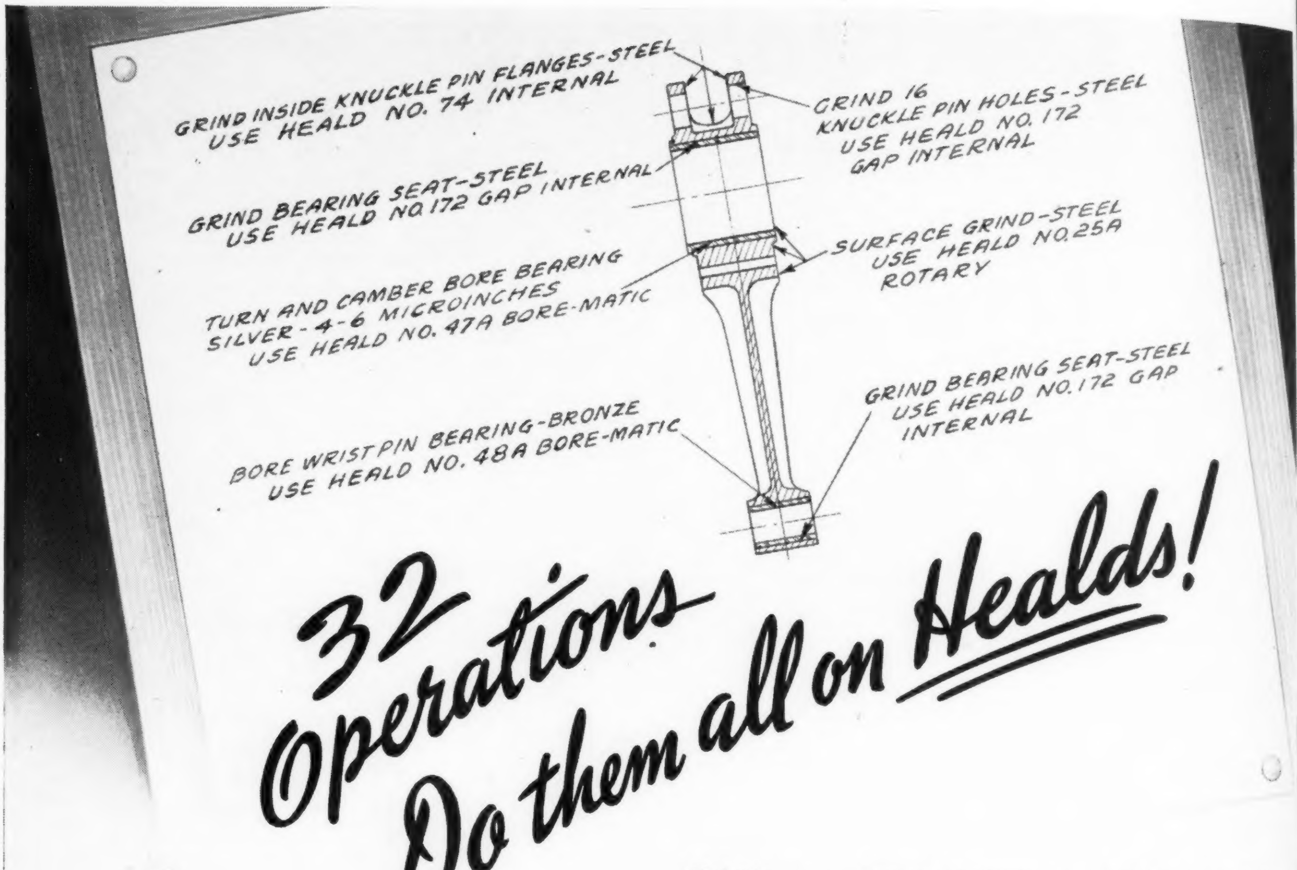
MARCH 1944—FEATURING NEW MACHINING METHODS

MACHINERY



32 Surfaces . . . Just two processes . . . borizing and grinding. Illustrative of these operations done on Heald Bore-Matics and Grinding Machines are those shown below.

Practically every working surface on this aircraft master rod is finished on Heald Precision Finishing Machines — all of the 32 surfaces indicated in the sketch above, in steel, bronze and silver.

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Heald builds *both* precision borizing and precision grinding machines . . . consequently we can recommend, without bias, the machine that will best meet your requirements. Precision plus production will play an important role in postwar manufacturing . . . let us help you get both with the *right* machine for the job.

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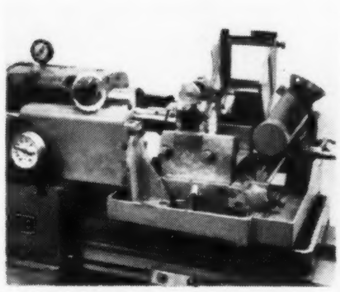
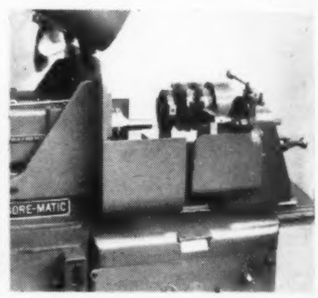
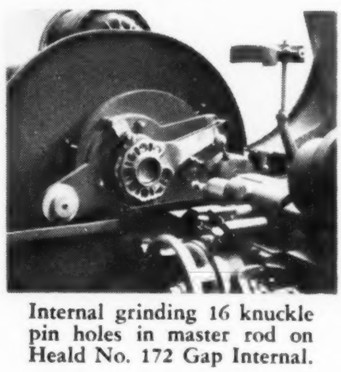


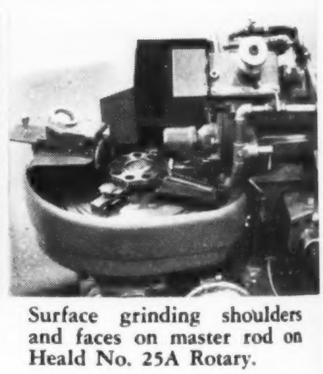
Contour boring silver master rod bearing on Heald No. 47A Bore-Matic.



Boring bronze wrist pin bearing in master rod on Heald No. 48A Bore-Matic.



Internal grinding 16 knuckle pin holes in master rod on Heald No. 172 Gap Internal.



Surface grinding shoulders and faces on master rod on Heald No. 25A Rotary.

HEALD

PRECISION FINISHING MACHINES

Borizing - Internal Grinding - Surface Grinding

DESIGN, CONSTRUCTION, OPERATION OF METAL-WORKING AND ALLIED EQUIPMENT

MACHINERY

MARCH, 1944

The long experience of the Ford Motor Co. in providing employment for handicapped workers points the way to the successful solution of a problem that will soon require the attention of all industry. The leading article to be published in April MACHINERY is an answer to the question: "How Can Industry Find Jobs for Disabled Veterans?" Other important articles in April will cover contour forming and bending, maintenance of electric motors, grinding to tenths of a thousandth on a high production basis, welding in jig construction, and care and use of thread cutting dies.

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Number 7

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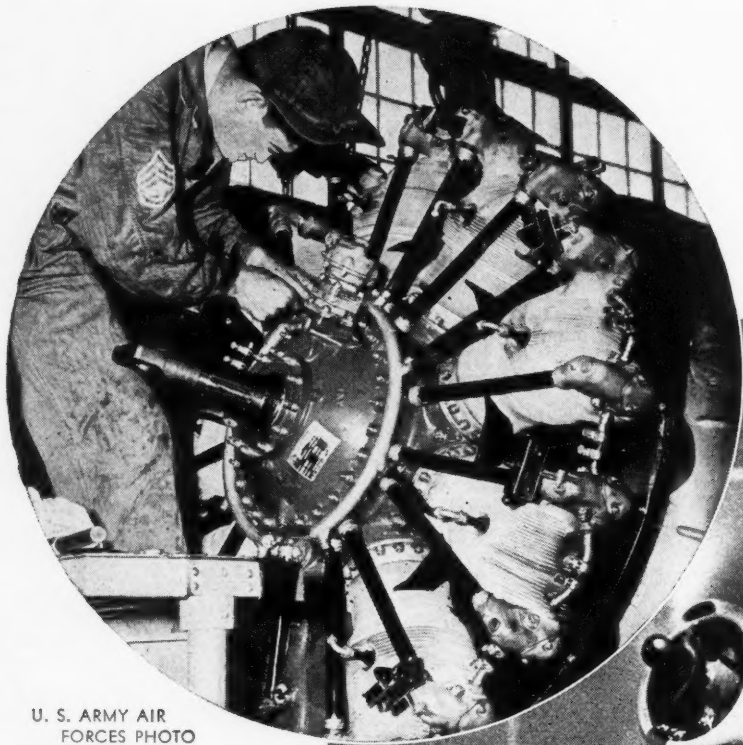


U. S. ARMY AIR FORCES PHOTO

OFFICIAL U. S. NAVY PHOTOGRAPH

The motor is the all important heart of our fast, powerful warplanes. In carrying tremendous bomb loads to distant targets at amazing speeds, in dive bombing, escaping enemy ack ack, battling enemy fighters and bringing home a crippled plane, the engines are under terrific strain and vibration. But American engines have proved they can take it and keep going, mission after mission, thanks to American engineering. One of the reasons for the excellent performance of our warplane engines is the minute accuracy of the specially designed — — LANDIS THREADED — — studs employed in the cylinder heads, blocks and crankshaft cases.

LANDIS MACHINE CO.

METAL-WORKING MAKES NEW STRIDES!

Carbide milling cutters with a negative radial rake and a negative helix angle have made it possible to mill steel parts at unprecedented cutting speeds. Because of the great interest in this latest shop development and the limited amount of information heretofore published, MACHINERY'S editors made an extensive investigation of negative-rake milling, which included visits to shops on the Pacific Coast, where the practice has been most widely applied. The information obtained, as well as other articles on advanced metal-working practice, is recorded in this issue.

Vol. 50 No. 7

MACHINERY

MARCH, 1944

Negative-Rake Milling Development in

Production Experiences of Prominent Aircraft Companies Who have Pioneered in the Development of the New Milling Technique that has Achieved Such Startling Results

By CHARLES O. HERB

A Revolutionary Shop Practice

THE aircraft industry has shown remarkable ingenuity in the development and application of metal-working practices to meet manufacturing problems peculiar to its product. Such processes as the forming of metal parts on hydraulic presses by using rubber instead of punches, and the milling of aluminum alloys at speeds previously undreamed of by shop men, need only be cited to indicate the progressiveness of the aircraft industry's production engineers.

Within the last year or so, this industry has pioneered in the use of carbide-tipped milling cutters with the blades set at negative rake and helix angles for the machining of steel parts at unprecedented speeds in operations involving interrupted cuts. Cutters of this type may not actually have first been conceived by engineers in the aircraft industry, but certainly much credit is due them for their wide and successful application. The remarkable results have been obtained in spite of considerable handicaps due to the lack of sufficiently powerful or rigid machine tools. Because of the successes that have been achieved in aircraft plants, negative-rake milling is spreading rapidly to other fields.

Definition of "Negative Rake" and "Negative Helix Angle"

Just what is meant by "negative rake" and "negative helix angle" in the nomenclature thus far used in connection with the new milling process will be understood from Fig. 2, which shows a drawing prepared by the Machinery Mfg. Co., Los Angeles, Calif. It will be apparent that the term "negative rake" means that the face of each carbide tip lies in an angular plane with respect to a radial line passing through the center of the cutter, and with the inner edge of the tip leading the outer edge. At the recent annual meeting of the American Society of Mechanical Engineers it was suggested that the term "negative radial rake" would be a more satisfactory designation of this condition.

The expression "negative helix angle" means that each carbide tip is so inclined when the cutter is viewed lengthwise that the inner edge is ahead of the outer edge. Some shop men refer to this as "shear angle." At the A.S.M.E. meeting referred to, it was suggested that "negative axial rake" would be a preferable term. This article will use the terms "negative rake" and "negative helix" because they are most commonly employed at present.

Designing milling cutters with a negative rake instead of a positive rake immediately raises the question as to why such a radical change has been made. The answer is that a negative rake gives a stronger cutting edge—one that will enable the cemented-carbide tips to better withstand the severe shocks that occur in taking interrupted cuts on steel.

However, considerably more power is required to drive negative-rake cutters, so much more that present-day machine tools are under-powered for this practice. Should manufacturers ever be able to produce cemented carbides with appreciably greater tensile strength, industry would again return to a positive rake for carbide-tipped cutters. On the other hand, machine tool builders will undoubtedly bring out machines adequately powered for the new practice.

A negative rake of 10 degrees and a negative helix angle of 10 degrees have proved satisfactory for the machining of both hardened and normalized or annealed steel in the experience of several concerns, although there are companies that vary these angles somewhat, depending upon the analysis of the material being cut. Negative-rake cutters are being applied both on the climb-cut principle and in the conventional manner. However, some shop men consider it almost mandatory to employ climb-milling with carbide cutters. This produces a much better finish on the work than the conventional method, and more work-pieces are obtained per grind of the cutter. It is, of course, important to elim-

Fig. 1. Milling Cutter with Inserted Blades Set to Negative-rake and Negative-helix Angles being Used on a Horizontal Boring Mill for Face-milling Connecting-rods for Reciprocating Steam Engines

inate all backlash in the table drive when climb-milling is performed.

The cutting action of negative-rake milling cutters tends to force the carbide tips more solidly against the cutter body, and thus subjects the cemented carbide to compression, in which respect it offers high resistance. This is exactly opposite to the action of positive-rake cutters, in which case the force against the tip tends to loosen it from its brazed seat and subjects the tip to a tensile stress. In this respect, cemented carbide is, of course, relatively weak.

The cutting edge of the carbide tips is also greatly strengthened when a negative rake is provided, because the lip angle is greater than 90 degrees. The shock of the impact on each tooth as it engages the work is taken a perceptible amount back of the cutting edge at a point where the tooth is thicker and stronger. Fewer carbide tips are required on a negative-rake cutter because of the high cutting speed and insufficient power at the spindle. Therefore, thicker tips can be used and adequate support provided for them. At the same time, plenty of space can be made available between the teeth for chips. As a guide in determining the desired number of teeth on a cutter, it may be mentioned that Lockheed practice is to make the number of teeth two more than the cutter diameter. An 8-inch cutter is made with ten teeth, a 10-inch cutter with twelve, and so on.

In addition to the high cutting speeds and feeds that can be employed with these milling cutters, a finished surface of exceptional smoothness and high polish is produced on the work, comparable only to a ground or burnished finish. There are conflicting opinions as to the reasons for this high finish, and also as to what actually happens in milling with negative-rake cutters. However, opinions are as yet largely a matter of conjecture, because there has been little scientific investigation of this subject.

The various aircraft companies employing the new practice have done so solely for the purpose of speeding up production and there has been little opportunity for research. However, a thorough scientific investigation is soon to be conducted by the California Institute of Technology, Pasadena, Calif., (sponsored by the Aircraft War Production Council, Inc.) with funds provided by the War Production Board, and a second investigation is under way at the University of Michigan. From these investigations much information should be derived of inestimable value in the future design of negative-rake cutters and machine tools for driving them.

The high finish may be due to the heavy rubbing action developed between the cutter tip and the work during chip removal. Some engineers hold to the opinion that this rubbing action is so severe that the surface of the work closely approaches the melting point of the metal, with

the result that the chips "flow" off the work ahead of the carbide tip. Certain it is that the chips are red-hot at the moment they are produced, and they turn blue upon cooling.

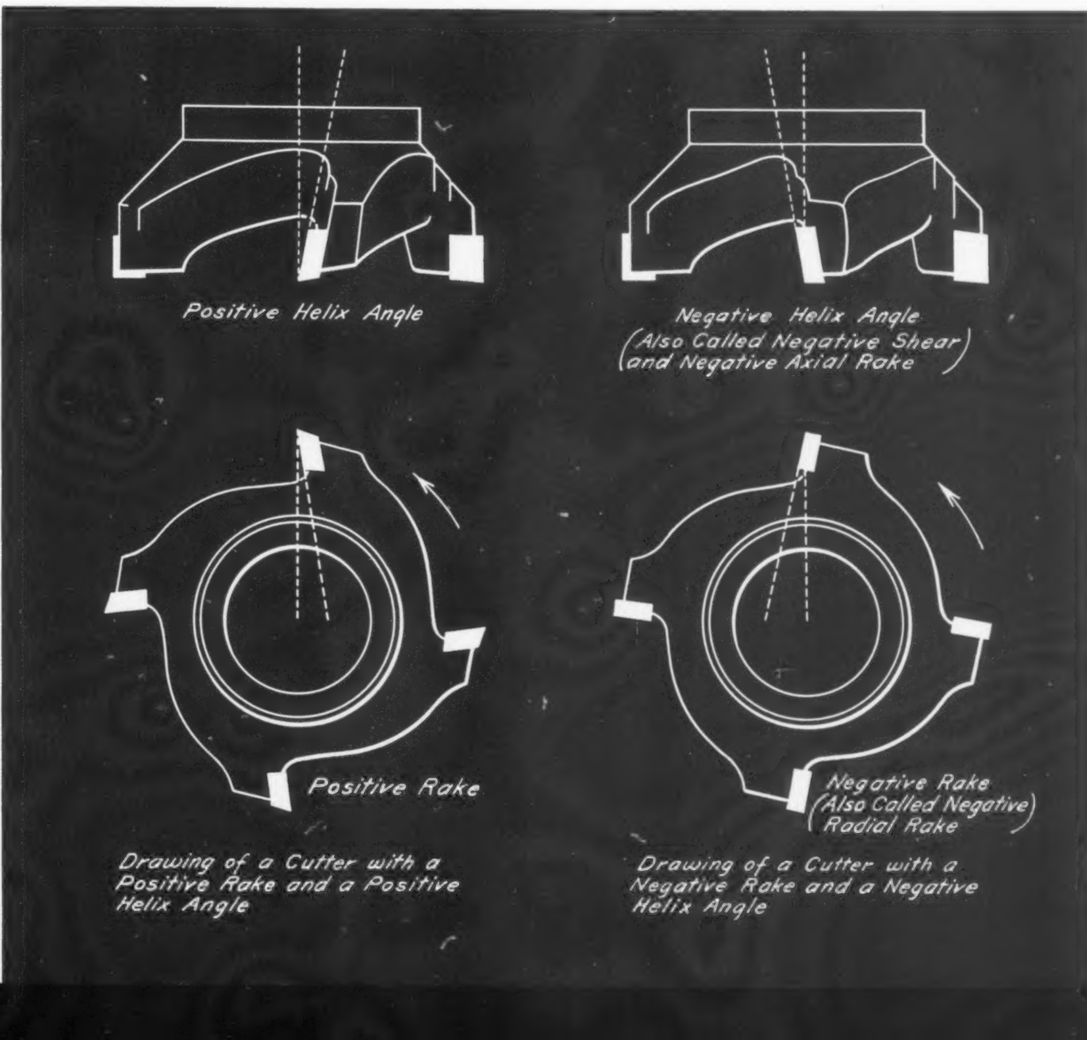
Sometimes the heat generated in the chips is so great that the thin edges of the chips actually burn and give the appearance of sparks from a welding torch. Cast-iron chips produced on a planer at the plant of the Defiance Machine Works, Inc., Defiance, Ohio, fitted with a negative-rake cutter and operated at a table feed of 225 feet a minute, are bright and shining on the under side, resembling steel chips. The work itself and the cutter tips do not become excessively hot, because the heat is largely confined to the chips.

It is an accepted fact that as the cutting speed is increased the built-up edge on cutting tools tends to disappear. By using the harder carbides with a lower coefficient of friction, the built-up edge is reduced to a minimum. It is the intermittent tearing away of a built-up edge that gives the so-called roughness to a machined surface. Therefore, if the built-up edge is reduced to a minimum, the finished surface will be correspondingly smoother.

The built-up edge action is also largely responsible for the pitting or cratering of tool tips. As these pits or craters enlarge, they approach the cutting edge and eventually result in chipping away of the edge. Engineers of the Defiance Machine Works have found that when negative-rake milling cutters are run slower than 400 feet per minute on steel, the cratering action becomes very evident after a comparatively short run. The same cutter speeded up above 400 feet per minute will run considerably longer before there are any signs of pitting.

As pointed out by Defiance engineers in a paper recently presented before the American Society of Mechanical Engineers, the higher speeds attained and the ability to cut harder material lead to the belief that plasticity of the metal removed plays a major part in the success of negative-rake cutting tools. With positive-rake cutters, chips of ductile metals seem to be removed by a varying degree of shear, tear, and flow. The material immediately ahead of the

Fig. 2. Diagrams that Explain the Meaning of "Negative Rake" and "Negative Helix" as Applied to Milling Cutters by Comparing Them with Cutters Having Positive-rake and Positive-helix Angles



tool point is trapped and compressed against the face of the tool until it is subsequently sheared or torn away by forces reacting at right angles to the face of the tool. When a negative-rake cutter is used, this compressive force becomes much greater since the forces at right angles to the top rake of the tool are not of a shearing nature.

The actual shearing of the metal is a result of the side rake or helix angle, whether it is positive or negative. In substance, the action is, therefore, a compression of the metal downward, tending to close the pores of the metal, and then a sidewise shearing of the compressed chip. This is one of the reasons for the exceptionally smooth finishes obtained, in the opinion of the Defiance engineers.

Coolant is not used with negative-rake milling cutters. First of all, experiments have not indicated that coolant helps the cutting action. Then, too, the alternate heating and cooling of the brazed tips when coolant is employed induces strains in the cemented carbide that tend to fracture the tips.

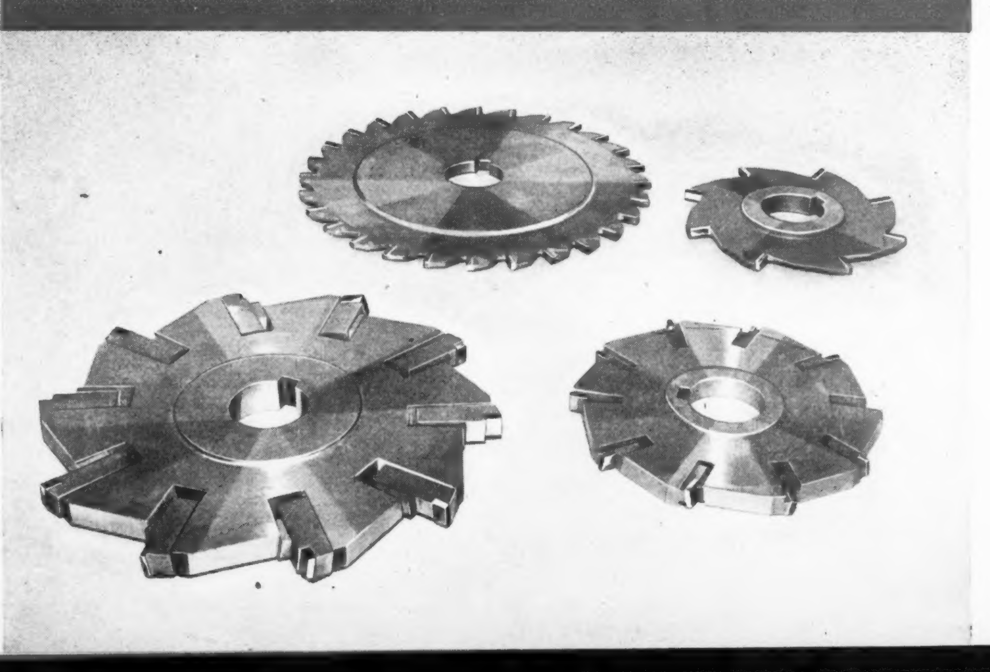
There are two general styles of negative-rake milling cutters. One is made with carbide-tipped steel shanks that are held in slots in the cutter bodies by means of wedges and machine screws, similarly to the way high-speed steel cutters of the inserted-blade type are attached to the cutter bodies. In the second style, the carbide tips are brazed directly to the cutter body. With the first style, the inserted blades can be conveniently adjusted radially as any of them become chipped or worn. Most cutters of this type have serrations in the body slots and on the tool shanks to facilitate this adjustment.

With the other or solid type of cutter, it is necessary to melt the braze of a broken or chipped carbide tip and then rebraze another tip in its place. Users of this type of cutter maintain that the carbide tips can be changed quickly when repairs are necessary, and that with both types of cutters all the carbide tips must be ground accurately whenever a blade setting is changed. An important requirement with both styles of cutters is that the carbide tips must be held in place with utmost rigidity.

A cutter of the inserted-blade type, designed by tool engineers of North American Aviation, Inc., is shown in Fig. 5, while Fig. 6 shows a Lockheed cutter with carbide tips brazed directly to the body. The construction of a typical Lockheed staggered-tooth negative-rake cutter is illustrated in Fig. 7. It will be seen that the peripheral edge of each tip is provided with a primary clearance of 2 degrees for a land 1/32 inch wide, and with a secondary clearance of 7 degrees. A Lockheed end-mill of 1 1/2 inches diameter made with two carbide tips having 10-degree negative-rake and negative-helix angles is illustrated in Fig. 8. A 4-inch end-mill with five carbide tips brazed to the cutter body is shown in Fig. 10. This cutter has a negative rake of 10 degrees and a negative helix angle of 10 degrees. It is a standard design brought out by the Machinery Mfg. Co.

Cutting speeds from 350 to about 400 surface feet per minute are being taken satisfactorily by negative-rake cutters operating on a produc-

Fig. 3. (Top) Two Slitting Saws that have Carbide Tips Provided with Negative Rake. (Below) Two Staggered-tooth Milling Cutters on which the Carbide Tips have Both a Negative Rake and a Negative Helix



tion basis on hardened chromium-molybdenum steel of S A E specification 4130. Cutting speeds from 400 to 800 surface feet per minute are commonly used on the same steel after it has been normalized or annealed.

Tests and actual practice have shown that the "bite" or feed per tooth should seldom be less than 0.003 inch. With a feed per tooth of less than 0.003 inch, the impact shock as the tooth enters the work-piece is at the very edge of the tooth, which is its weakest point. This practice would shorten the life of the cutter between grinds. In one test, the cutter life between grinds was increased 200 per cent by simply raising the feed per cutter tooth from 0.005 to 0.010 inch. The table feed was doubled and the cutting speed left unchanged.

Experiments that Involved Extreme Cutting Speeds

With respect to cutting speeds, it is of considerable interest to note the experiences of the Joshua Hendy Iron Works, Sunnyvale, Calif., in milling bearing caps of S A E 1015 carbon steel. Tests were conducted on a Milwaukee knee type horizontal milling machine equipped with a 6-inch hyper-milling cutter having eight teeth.

In the first trial, the cutter speed was set at 730 feet per minute and the table feed at 10 1/2 inches per minute, which gave a feed per tooth of 0.0028 inch. The operation was performed on the climb-cut principle, and gave a very poor finish on the work. Another piece was then milled at the same speed and feed, but the operation was performed in the conventional manner, and a considerably improved finish was obtained. The table feed was then stepped up to 17 1/2 inches per minute, which gave a feed per tooth of 0.0047 inch. Again the finish was poor, indicating that the feed was too great.

Next the cutter speed was increased to 895 feet per minute and the table feed reduced to 10 1/2 inches per minute, which gave a feed per tooth of 0.0023 inch. This resulted in an improved finish on the work. The wear on the cutter teeth was negligible.

The cutter speed was then raised to 1075 feet per minute, the table feed of 10 1/2 inches per minute being retained, which gave a feed per tooth of 0.0019 inch. A finish comparable to that obtained in grinding resulted when two passes of the cutter were made at this speed and feed. However, chatter occurred until the cutter had been fed a distance of about 3 inches, or half the diameter of the cutter across the work. Then chatter ceased and the finish became smooth.

This indicated that either the spindle had play or the cutter was untrue. An investigation showed that the cutter adapter was 0.006 inch out of line. When another adapter was provided, the error was reduced to 0.001 inch. As this change, however, did not improve the work finish, the spindle was checked. It was found to be true and sufficiently tight, considering the high peripheral speed of the cutter.

The cutter speed was then raised again to 1611 feet per minute, and the table feed increased to 17 1/2 inches per minute, the feed per tooth being 0.0021 inch. At this point some

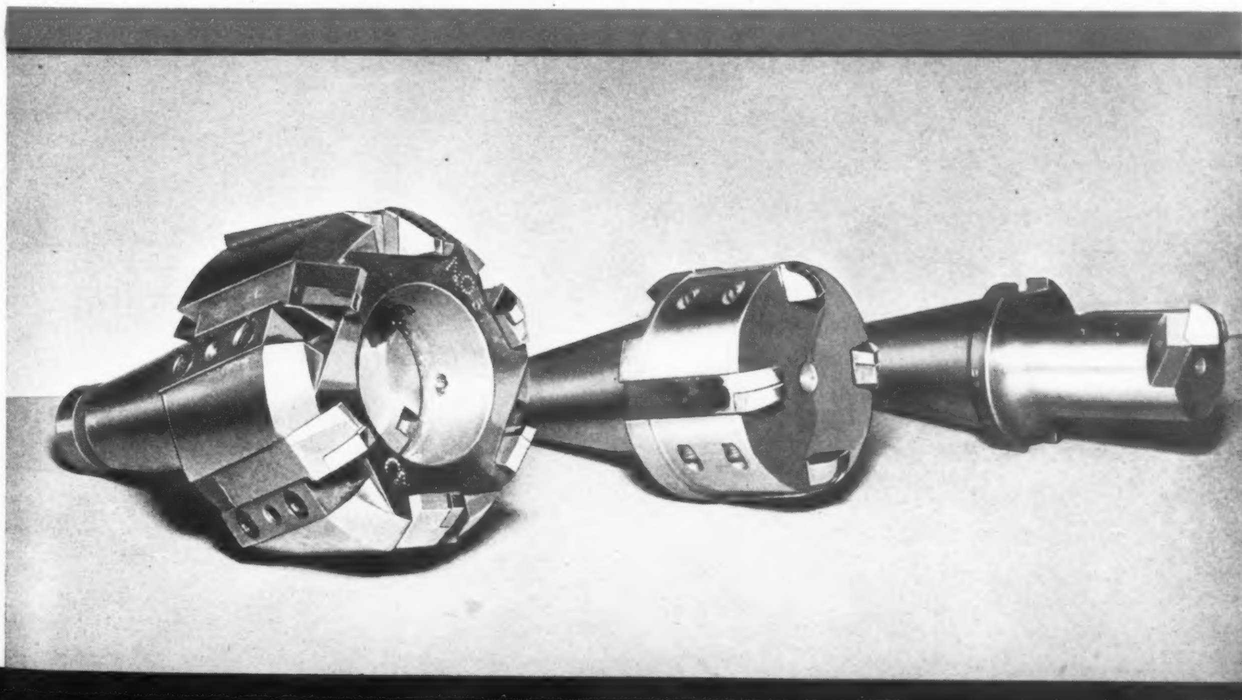


Fig. 4. Small-diameter Face-milling Cutters Developed by Boeing Engineers for Taking Light Cuts on Steel at High Speeds and Obtaining an Exceptionally Good Finish on the Work

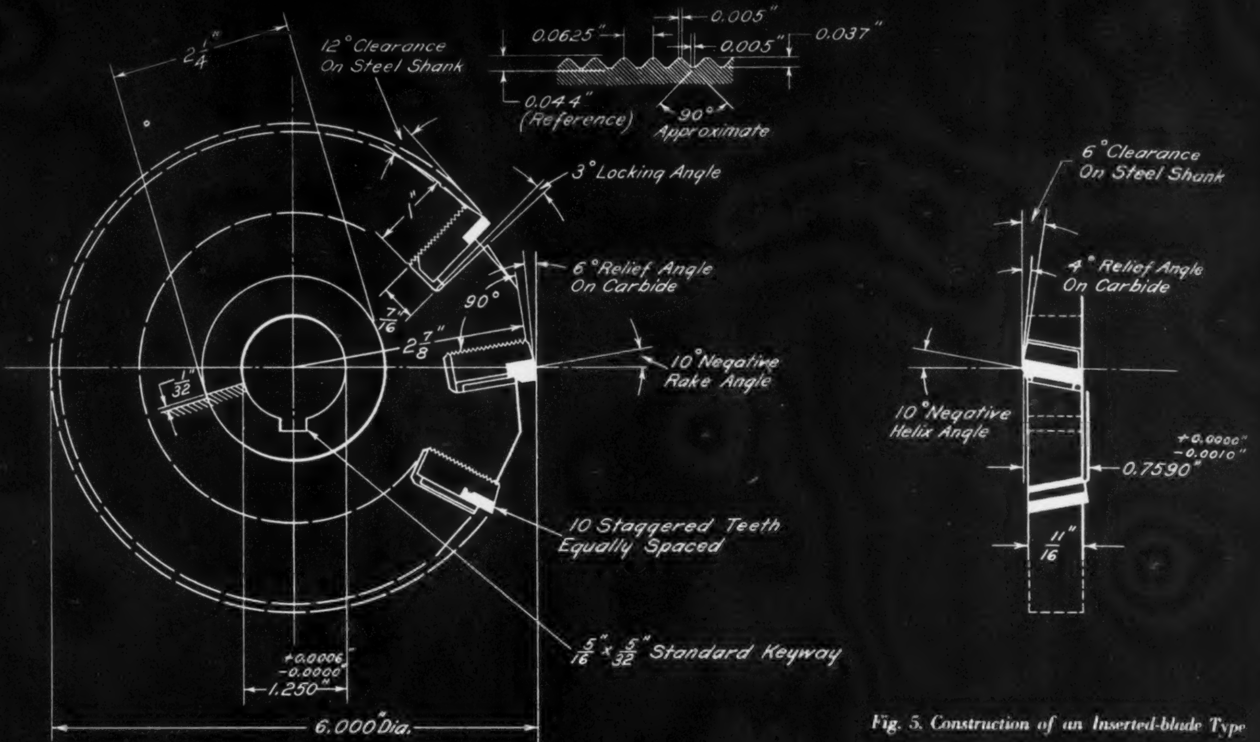


Fig. 5. Construction of an Inserted-blade Type of Face-mill with Cutters Set to Negative-rake and Negative-helix Angles of 10 Degrees Each

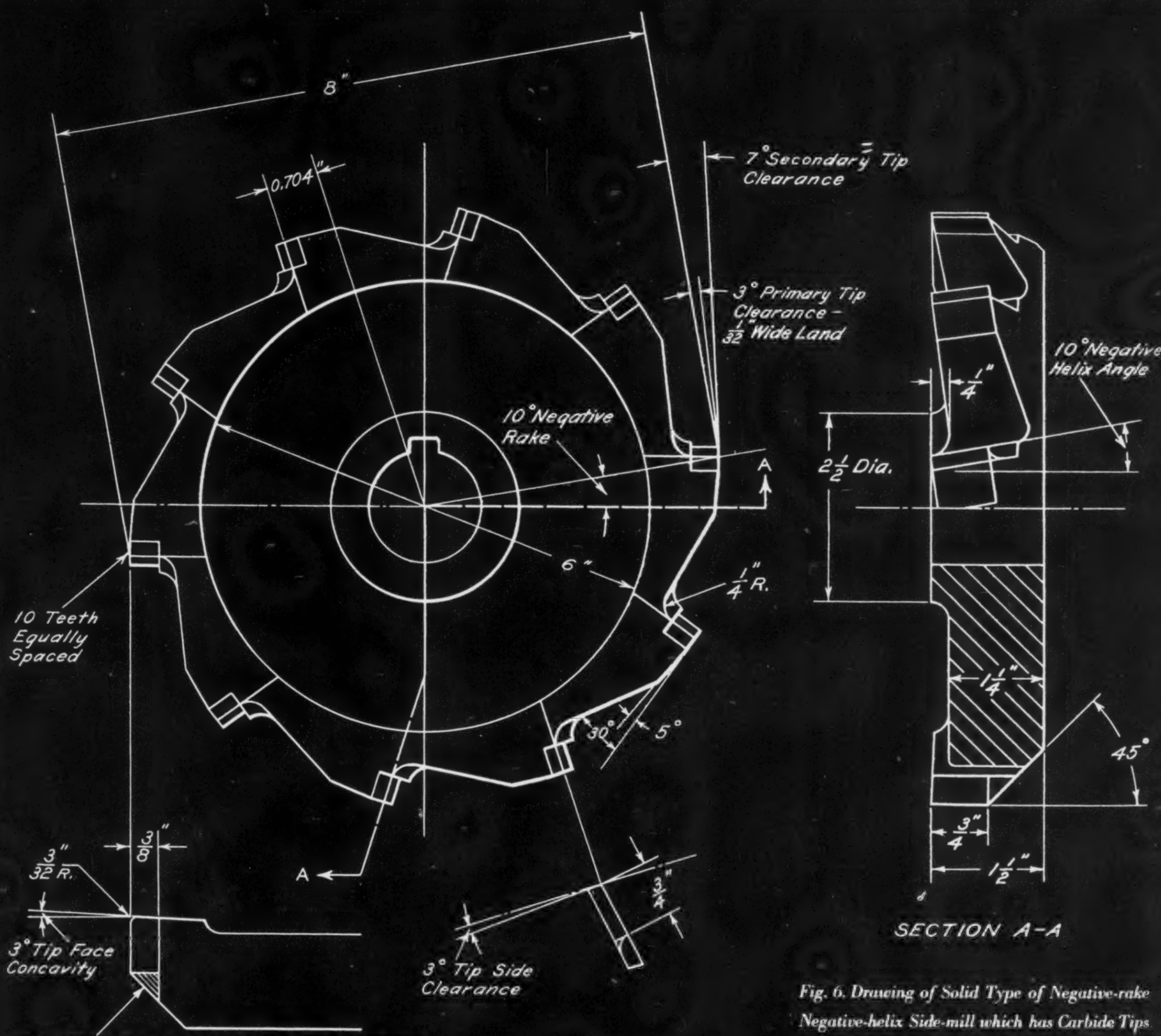


Fig. 6. Drawing of Solid Type of Negative-rake Negative-helix Side-mill which has Carbide Tips Brazed Directly to a Carbon-steel Cutter Body

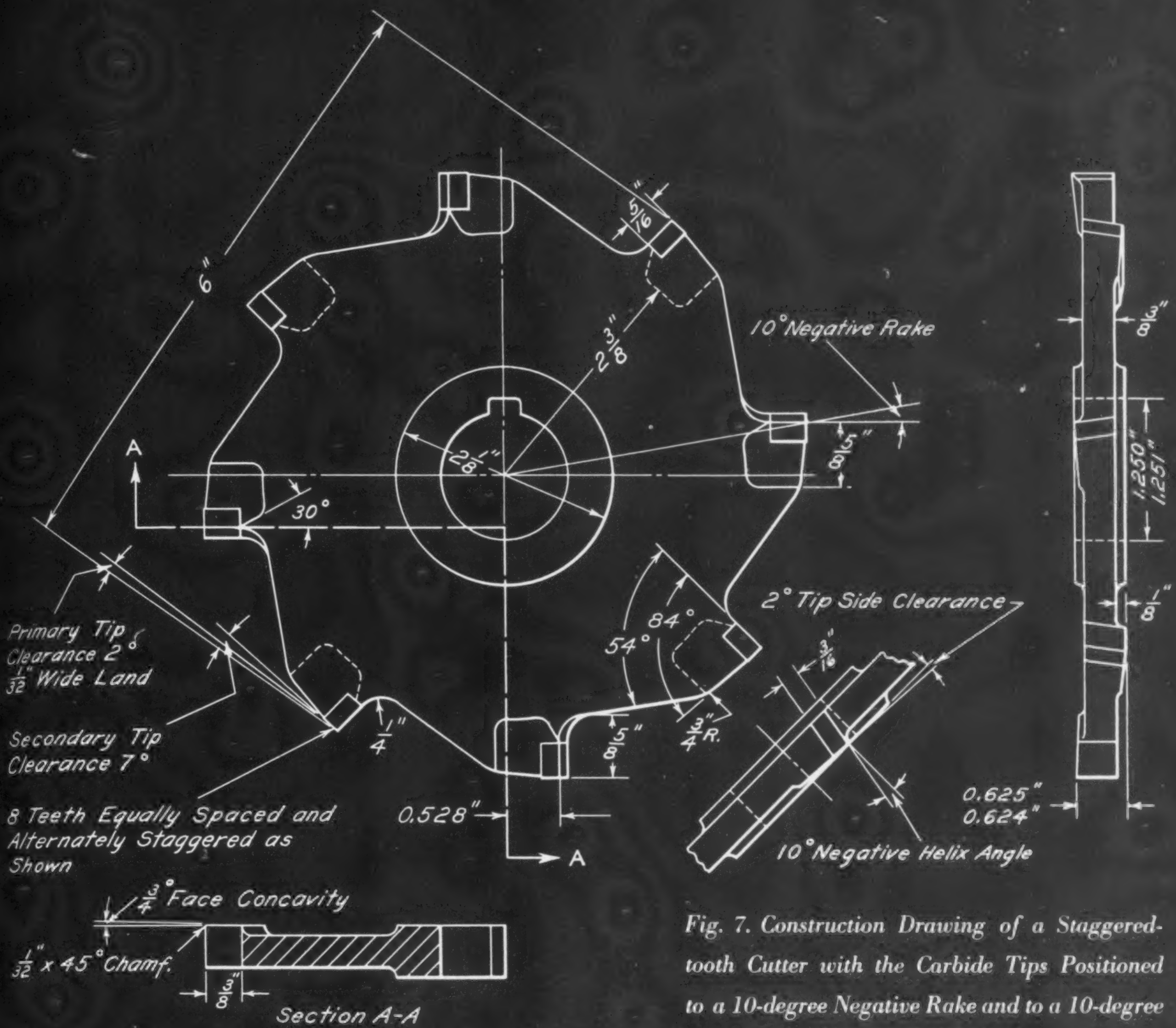


Fig. 7. Construction Drawing of a Staggered-tooth Cutter with the Carbide Tips Positioned to a 10-degree Negative Rake and to a 10-degree Negative-helix Angle

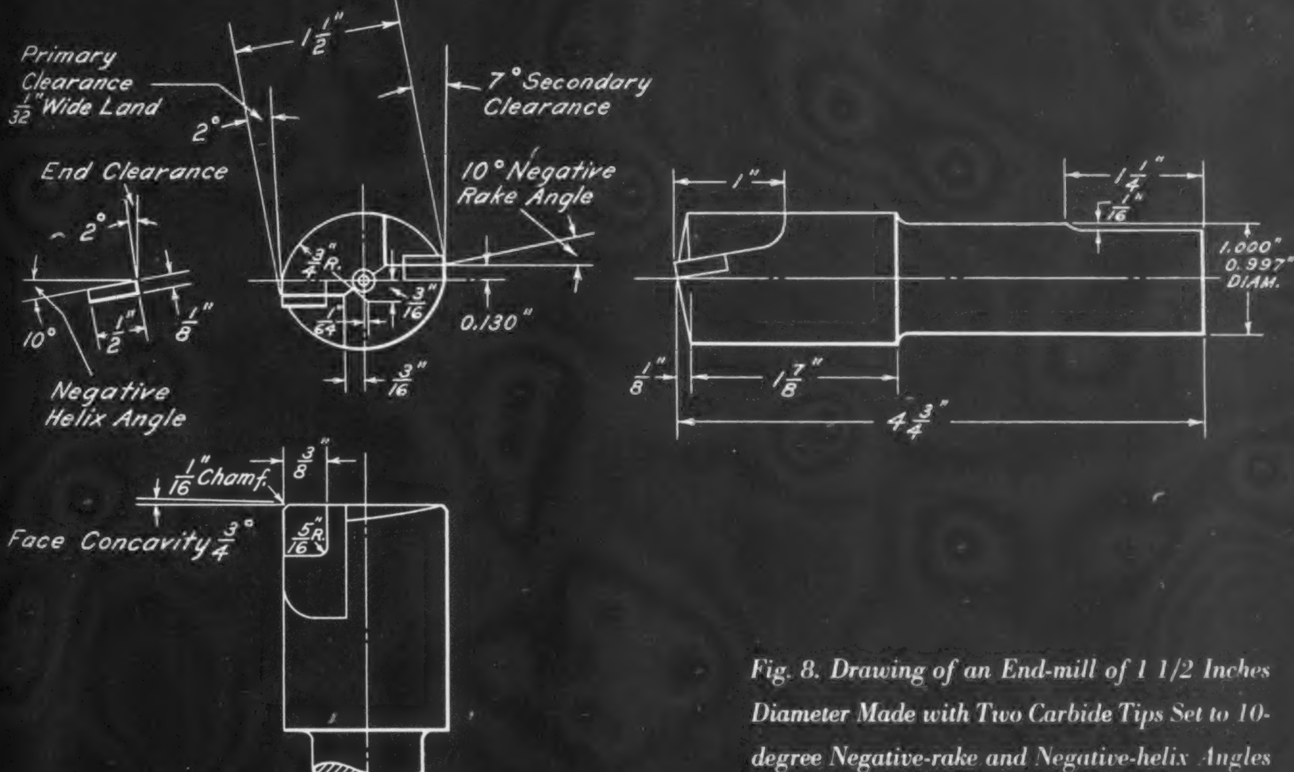


Fig. 8. Drawing of an End-mill of 1 1/2 Inches Diameter Made with Two Carbide Tips Set to 10-degree Negative-rake and Negative-helix Angles

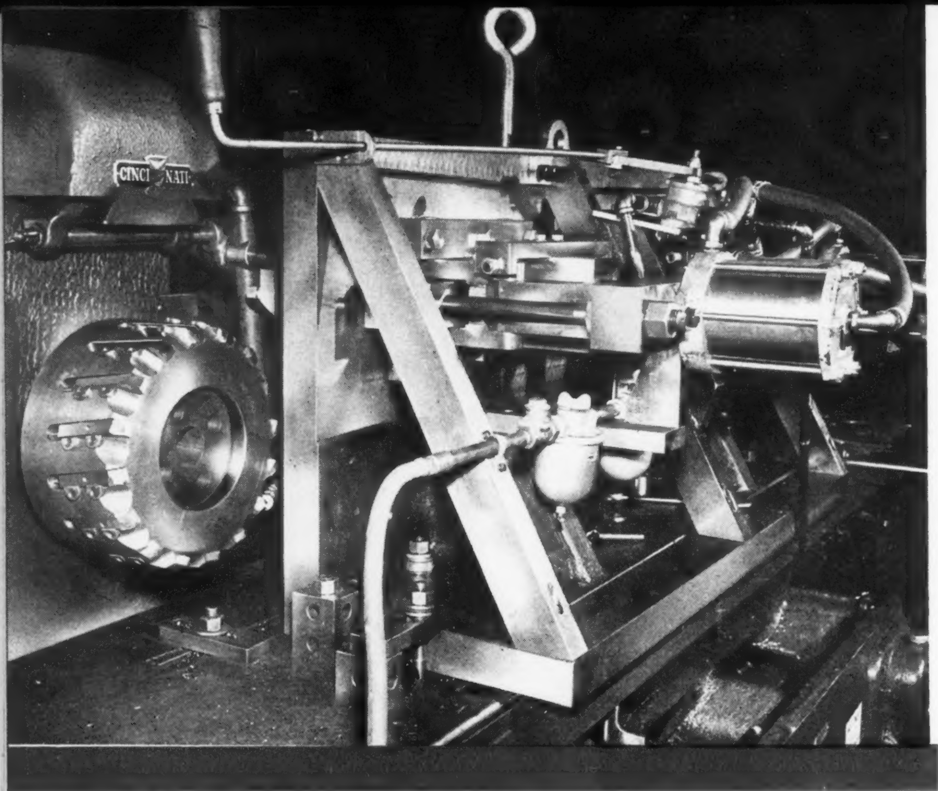


Fig. 9. Negative-rake Milling Cutter that Cuts Chromium-molybdenum Steel to a Depth of 0.300 Inch with a Table Feed of 18 Inches a Minute in the Boeing Aircraft Plant

cratering and washing of the tool tip was noted. The finish once more closely approached that obtained in grinding. With another increase in the table feed to 21 inches per minute, an equally good finish was obtained. Using the same cutting speed, table feeds of 25, 30, and 35 inches per minute were employed, and it was found that the finish was equally good at all feeds.

The cutter used in these tests had a negative rake of 7 degrees and a helix angle of 15 degrees. It was provided with Kennametal tips. The cutter was in the milling machine for about five hours, and ran fairly constantly for nearly two hours. Thirty pieces of work were completed at speeds ten times those used with high-speed steel cutters.

These experiments and similar ones conducted in other plants seem to indicate that even more spectacular performances may be possible with negative-rake cutters than those now being achieved in regular production when machine tools of greater power and rigidity are available.

Production Operations at Boeing Aircraft Co.

Some of the production operations of the Boeing Aircraft Co., Seattle, Wash., which has been one of the foremost concerns in the application of negative-rake milling cutters, will now be described. This concern uses negative-rake cutters with inserted carbide-tipped blades exclusively, except for narrow slitting saws which are constructed with the carbide tips brazed directly to the boiler-plate body. These cutters are used in manufacturing parts for Boeing Flying Fortresses. Fig. 3 shows slitting saws in the top row and staggered-tooth inserted-blade cutters at the bottom. The negative rake is readily apparent on these cutters.

In Fig. 4 are shown several styles of small face-milling cutters. The one at the left has a cutting diameter of 5 inches, and is made with six cutter inserts. This tool is employed for taking light cuts at high speeds, and gives an exceptionally good finish. The middle cutter is made with four blades and the cutter tips are ground to a generous radius as required for taking a finishing step-cut on terminal plates. The cutter at the right has only one carbide tip and is intended for the same operation.

Boeing face-milling cutters are ground with a negative rake of from 3 to 6 degrees, depending upon the type of machine tool on which the cutter is to be used and the available power of the machine. The common practice is to make all cutters with a negative rake of 10 degrees and then grind the rake to a smaller angle as decided upon after trial tests. If sufficient machine power were available all of these cutters would be used with a negative rake of 10 degrees. Side-milling cutters are made with a negative rake and a negative helix angle of 10 degrees.

Incidentally, according to Boeing experience, machine tools for heavy-duty negative-rake milling should be driven by electric motors of at least 40 H.P. rating in order to obtain maximum benefits from this new cutting theory. This recommendation is concurred in by production men in other factories using negative-rake cutters. On one milling machine in the Boeing plant

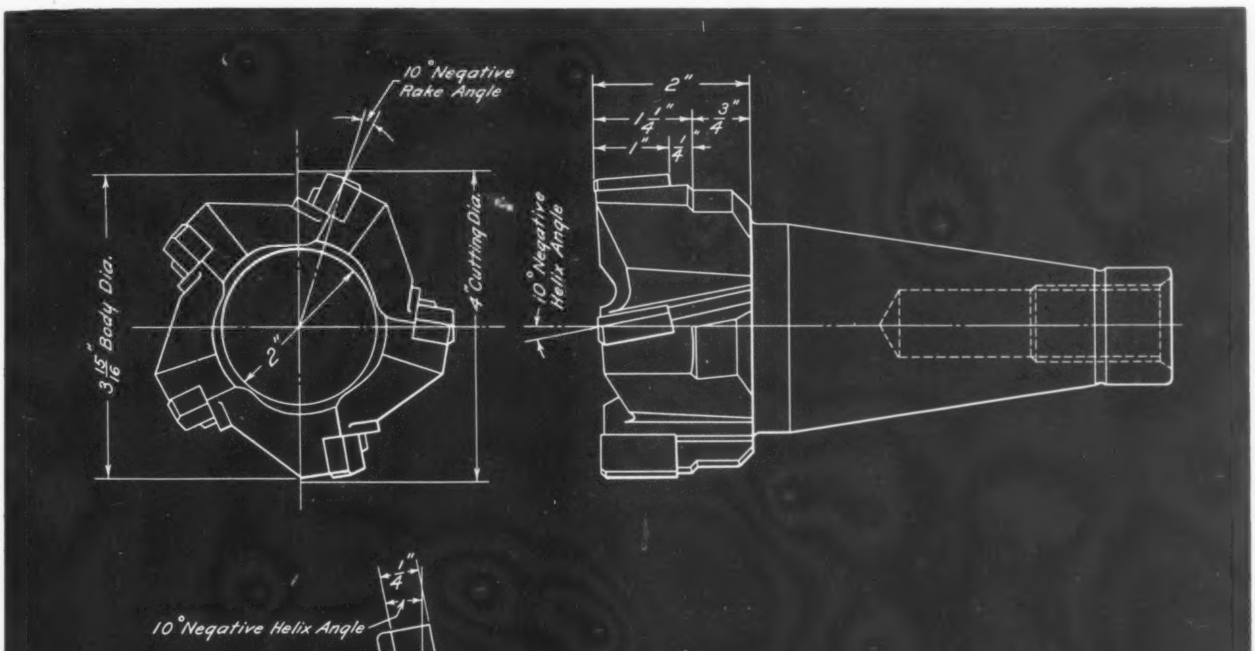
driven by a 20-H.P. motor, the load in cutting has been as high as 168 per cent of the rated motor capacity. Flywheels are used on machine spindles and cutter-arbors wherever possible, so as to store up energy between cuts and insure concentric cutter rotation. Flywheels weighing as much as 250 pounds each are used.

About the toughest negative-rake milling job in the Boeing plant consists of taking a roughing cut on wing terminal plates of S A E 4340 chromium-molybdenum steel having a hardness of 321 Brinell. This operation is performed on the Cincinnati Hydromatic milling machine shown in Fig. 9, which is equipped with a 12-inch diameter face-mill having sixteen teeth. These teeth are ground to a negative rake angle of 6 degrees and the helix angle is 10 degrees. The cutter is run at 113 R.P.M., which gives a cutting speed of 365 feet per minute. The table feed is such as to give a feed per cutter tooth of 0.010 inch. The depth of cut is 0.300 inch.

Fig. 12 shows this cutter in action. The production of chips is so fast that provisions were made for discharging a stream of compressed air from the center of the cutter body to each tooth of the cutter at the point where the teeth leave the cut, so as to blow away the chips. In addition, there are generous chip pockets in back of each cutter blade, and these pockets are shaped so as to curl the chips away from the work. Without these provisions, chips would often be recut as they adhered to the cutter, a condition that would tend to produce tip fracture and breakage.

As many as 150 pieces are milled per sharpening of the cutter blades. This is the operation in which the motor is loaded as much as 168 per cent of its capacity. As the nature of the oper-

Fig. 10. Drawing of 4-inch Negative-rake Negative-helix End-mill with Five Carbide Tips Brazed to Cutter Body



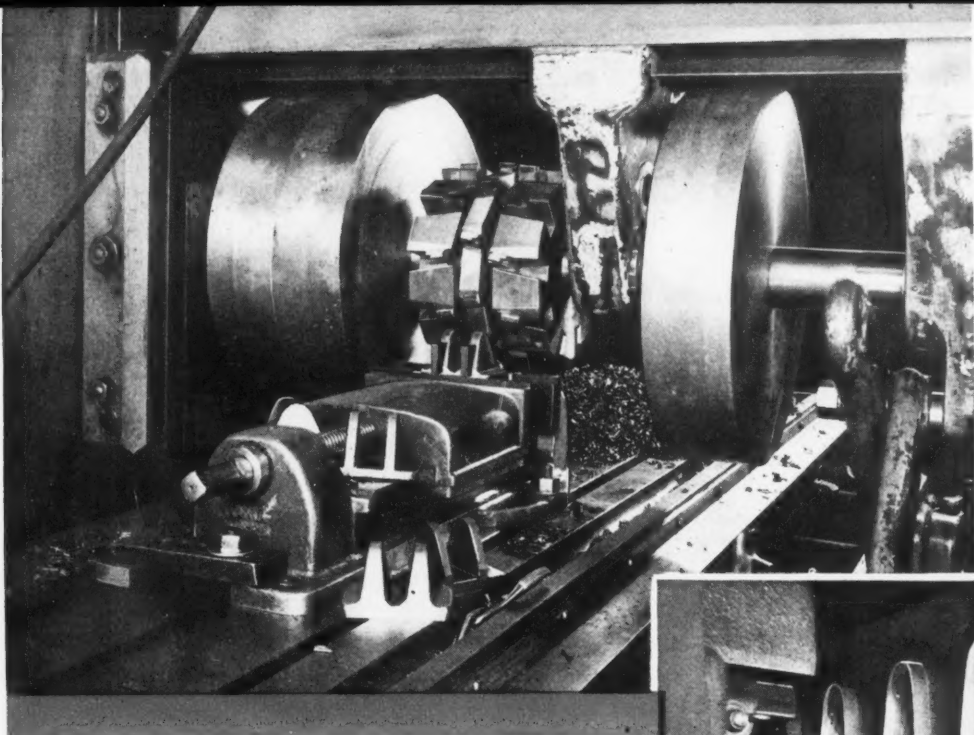


Fig. 11. (Above) Employing Three Milling Cutters of the Negative-rake Negative-helix Type Simultaneously on Chrome-molybdenum Steel Fittings. Note the Heavy Flywheels Provided on the Cutter-arbor

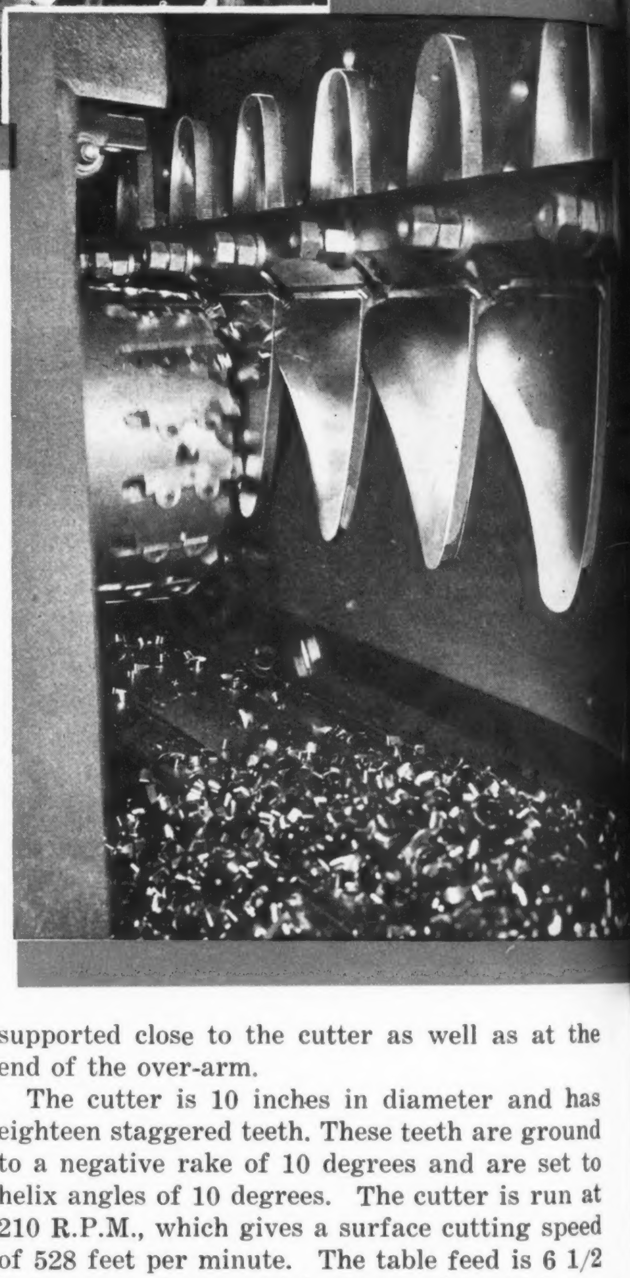


Fig. 12. (Right) Chips are Produced so Fast with Cutter Shown in Fig. 9 that Provision is Made for Discharge of a Stream of Compressed Air from Center of Cutter Body to Blow the Chips from the Cutter Teeth

ation did not permit the use of a flywheel, the cutter body was made unusually heavy.

The terminal plates are finished on a vertical-spindle milling machine equipped with cutters of the style seen at the middle and right in Fig. 4. The cutting speed in finishing is approximately 500 surface feet per minute, and the feed per cutter tooth 0.008 inch. The light cut taken across the plates is increased to a depth of 5/16 inch where a beveled shoulder was left by the roughing cutter. This shoulder is rounded to a 1/2-inch radius. The finish is directly comparable to a ground finish.

Another outstanding Boeing job consists of milling a slot approximately 1 inch wide to a depth of 1 11/16 inches for a length of 2 inches through terminal forgings of S A E 4130 chromium-molybdenum steel having a hardness as high as 240 Brinell. This operation is illustrated in Fig. 13. A staggered-tooth cutter is employed which is made with a body having a heavy cross-section on both sides of the inserted blades so as to obtain the same effect as that which would be provided by flywheels. The arbor is supported close to the cutter as well as at the end of the over-arm.

The cutter is 10 inches in diameter and has eighteen staggered teeth. These teeth are ground to a negative rake of 10 degrees and are set to helix angles of 10 degrees. The cutter is run at 210 R.P.M., which gives a surface cutting speed of 528 feet per minute. The table feed is 6 1/2 inches per minute, which gives a chip thickness of 0.003 inch. From 230 to 300 pieces are slotted per grind of the cutter. The illustration clearly shows the type of chips obtained.

An operation in which three cutters are used simultaneously for milling inside and outside surfaces of the yoke on tail-gear fittings is illustrated in Fig. 11. The middle cutter is provided with staggered teeth for milling on both sides, while the other two cutters are of the single side-mill type. Finished and unfinished pieces of work are seen at the front of the fixture. They are forgings of S A E 4130 chromium-molybdenum steel, and have a hardness of 240 Brinell. Particular attention is called to the heavy flywheels mounted on the cutter-arbor.

The cutters are all 10 inches in diameter and are supplied with ten teeth, of which the rake angle and helix angle are both 10 degrees. These cutters are run at 210 R.P.M., which gives a cutting speed of 549 feet per minute, and the table feed is 10 inches per minute, which is equivalent to a feed per tooth of 0.005 inch.

Another job of especial interest consists of straddle-milling a number of cylindrical parts held in a multiple fixture, as shown in Fig. 14. These parts are 1 1/4 inches in diameter and are straddle-milled to a width of 1/2 inch for a depth of 11/16 inch. The pieces are S A E 4130 chromium-molybdenum steel and have a hardness of 195 Brinell. During the first runs on this job a 7-inch cutter having eight teeth was used at a speed of 453 R.P.M., or a peripheral speed of 835 feet per minute. With a 13-inch table feed, the "chip load" (or feed per tooth) was less than 0.004 inch. Approximately 300 parts were obtained per grind.

Then the 9 1/2-inch cutter seen in the illustration, which has six teeth, was substituted.

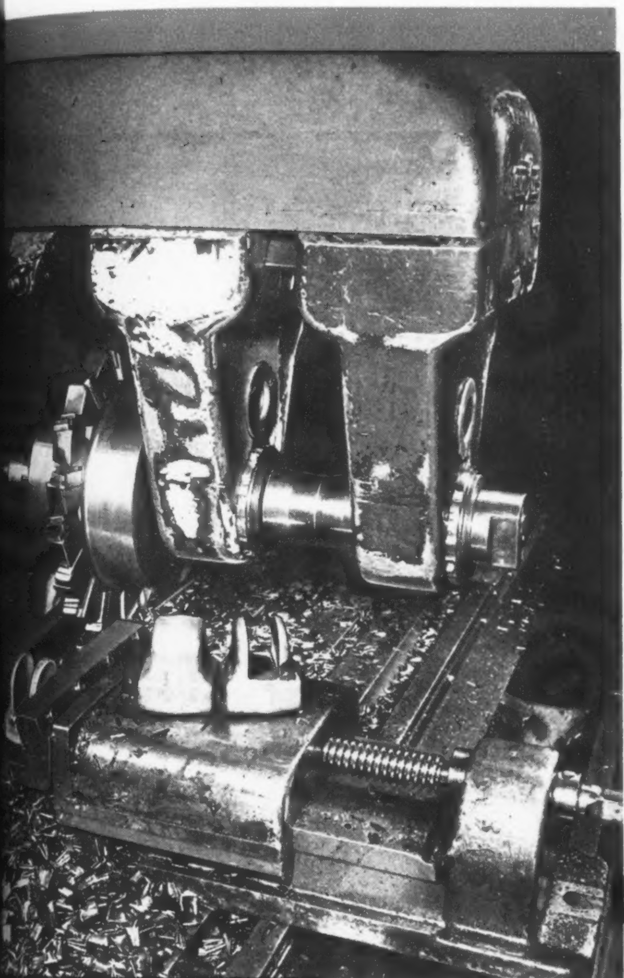
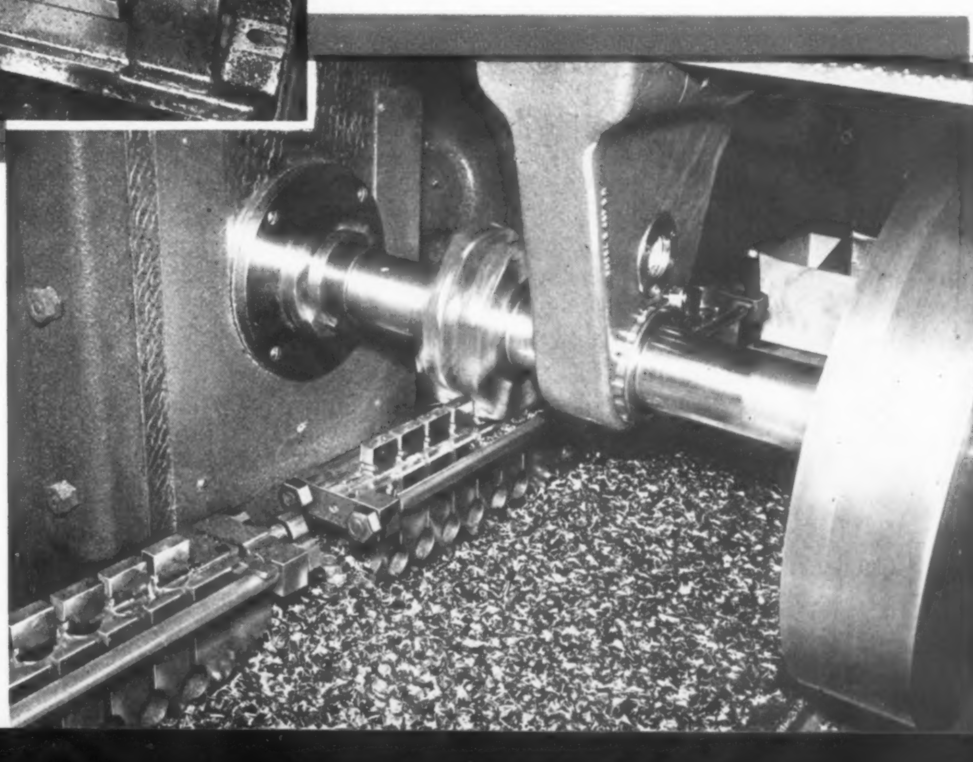


Fig. 13. (Left) Milling a Slot 1 Inch Wide by 1 11/16 Inches Deep for a Length of 2 Inches through Chromium-molybdenum Steel Forgings at a Cutting Speed of 528 Feet per Minute. The Table Feed is 6 1/2 Inches a Minute

Fig. 14. (Below) High-production Job on Chromium-molybdenum Steel with a Negative-rake Cutter Run at a Speed of 500 Feet per Minute. The Table Feed is 13 Inches a Minute



NEGATIVE-RAKE

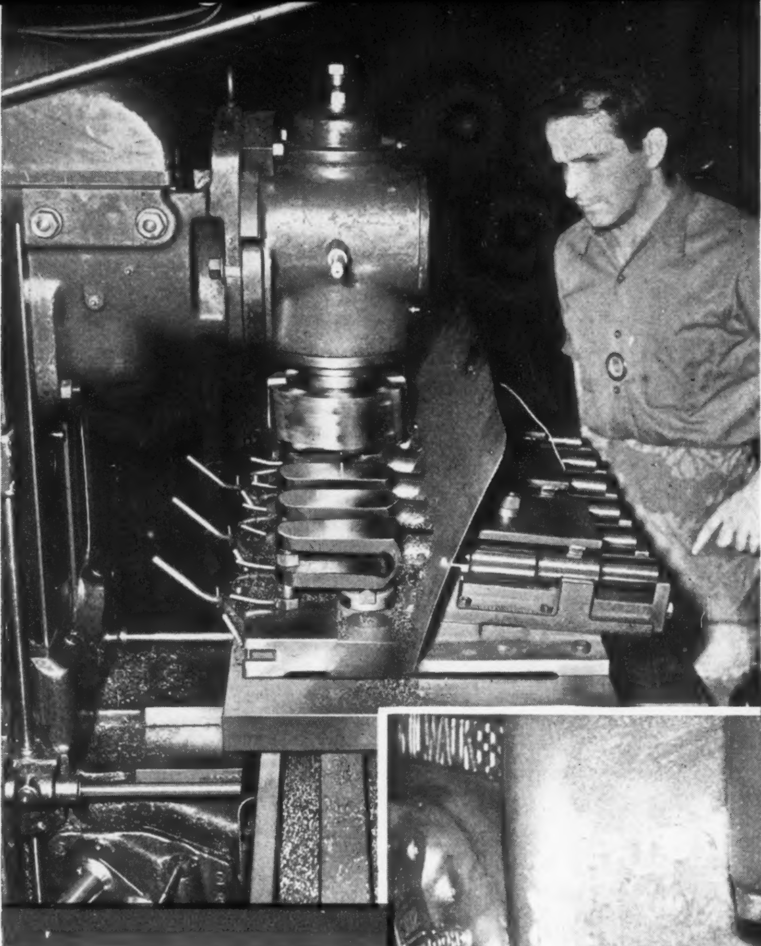
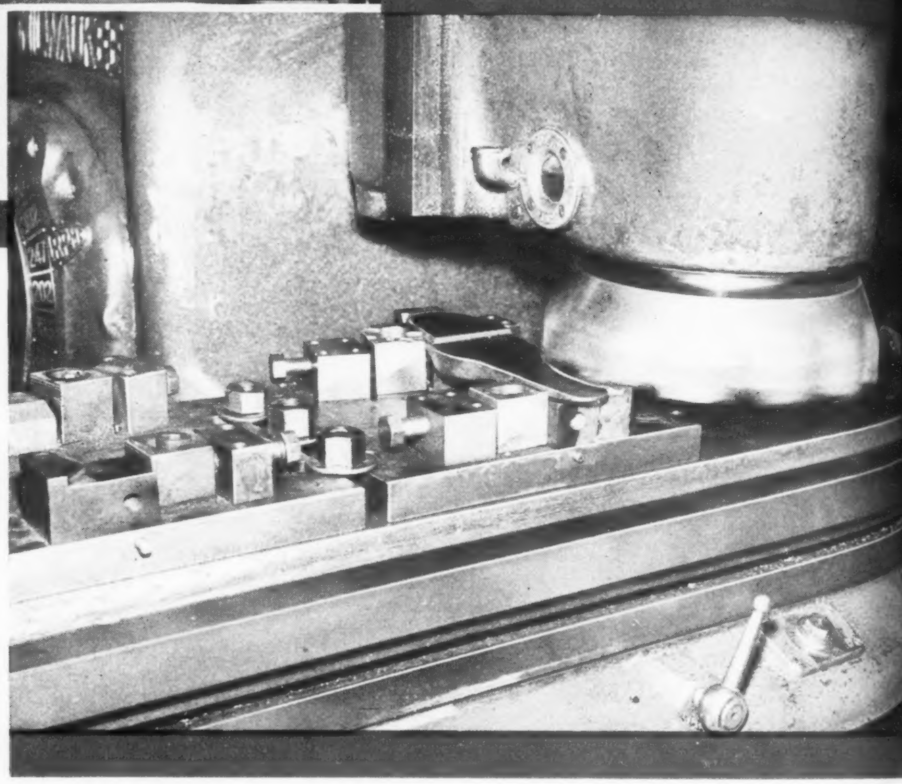


Fig. 15. (Left) Rough- and Finish-milling the Yoke End of Wing Terminals. Forty-two Forgings are Roughed and Finished per Grind of the Cutter

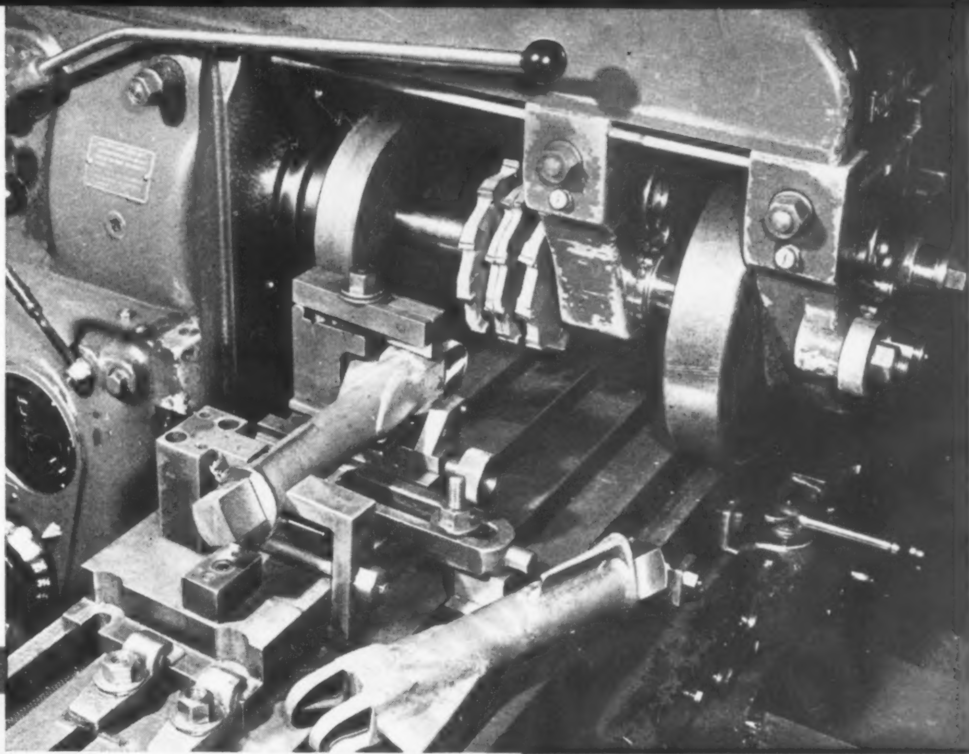
Fig. 16. (Below) Milling Chromium-molybdenum Steel Forgings of 205 Brinell Hardness with a Table Feed of 12 1/2 Inches per Minute and a Depth of Cut of 1/8 Inch



After increasing the table feed to 14.inches per minute, which gives a "chip load" of 0.007 inch, the production was increased to 493 parts per grind. A further increase in production per grind was obtained by decreasing the cutter speed to 198 R.P.M. and the table feed to 13 inches per minute, which resulted in a "chip load" of nearly 0.011 inch. In this case, 1100 parts were obtained per sharpening of the cutter. Both of the cutters used on these parts are ground to a negative rake angle of 10 degrees and have a negative helix angle of 10 degrees.

In Fig. 15 is shown a set-up used in taking heavy roughing and light finishing cuts on the yokes of wing terminals. The practice is to finish-mill forty-two terminals and then rough-machine another batch of forty-two terminals with each grind of the negative-rake milling cutter. These terminals are heat-treated forgings of S A E 4340 steel (341 Brinell).

The cutter is 7 1/2 inches in diameter, and is made with eight inserted teeth ground to a negative rake of 5 degrees and set to a negative helix of 10 degrees. The speed of the cutter is 350 R.P.M., or 687 feet per minute. The table feed is 7 5/8 inches per minute, which gives a 0.003 inch "chip load." In rough-milling, the depth of cut is from 0.050 to 0.060 inch, and in finish-



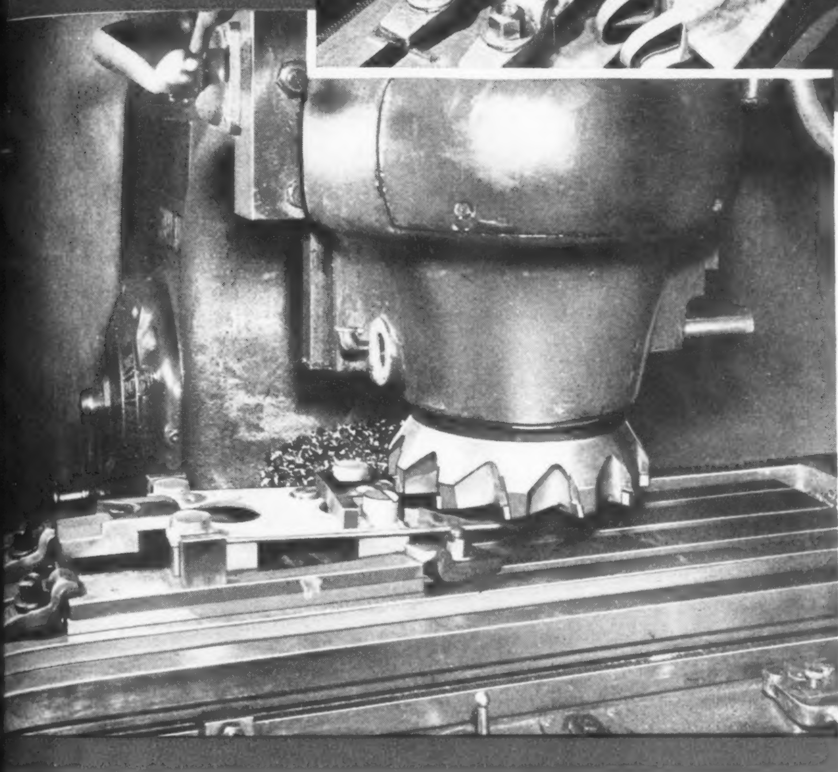


Fig. 17. (Above) The Yoke on Shock Strut Fittings is Finished by Simultaneous Application of Four Negative-rake Negative-helix Milling Cutters

Fig. 18. (Left) Another Operation on Chromium-molybdenum Steel Forgings, Performed with a 10-inch Twelve-tooth Solid Cutter. The Table Feed is 17 1/2 Inches per Minute, and the Depth of Cut 3/16 Inch

milling from 0.010 to 0.012 inch. The surfaces milled are approximately 3 inches wide by 6 inches long.

Lockheed Uses Solid Type Negative-Rake Cutters Exclusively

The Lockheed Aircraft Corporation, Burbank, Calif., has also been in the forefront in the development and application of negative-rake milling cutters. This company uses solid type cutters with the carbide tips brazed directly to the bodies exclusively in all sizes up to 12 inches diameter. Lockheed engineers maintain that the more "punishment" that is given negative-rake cutters in the way of heavier cuts, the longer the cutters seem to stand up.

To prove this point, a test job is cited in which 125 parts of S A E 4130 steel with an area of approximately 2 by 2 inches were machined by one cutter before resharpening was necessary. The feed per cutter tooth was 0.005 inch. After the cutter was resharpened and the feed per tooth was doubled to 0.010 inch, 315 parts were produced before resharpening was necessary. The depth of cut in both cases was 1/8 inch.

When one of these cutters is mounted on a

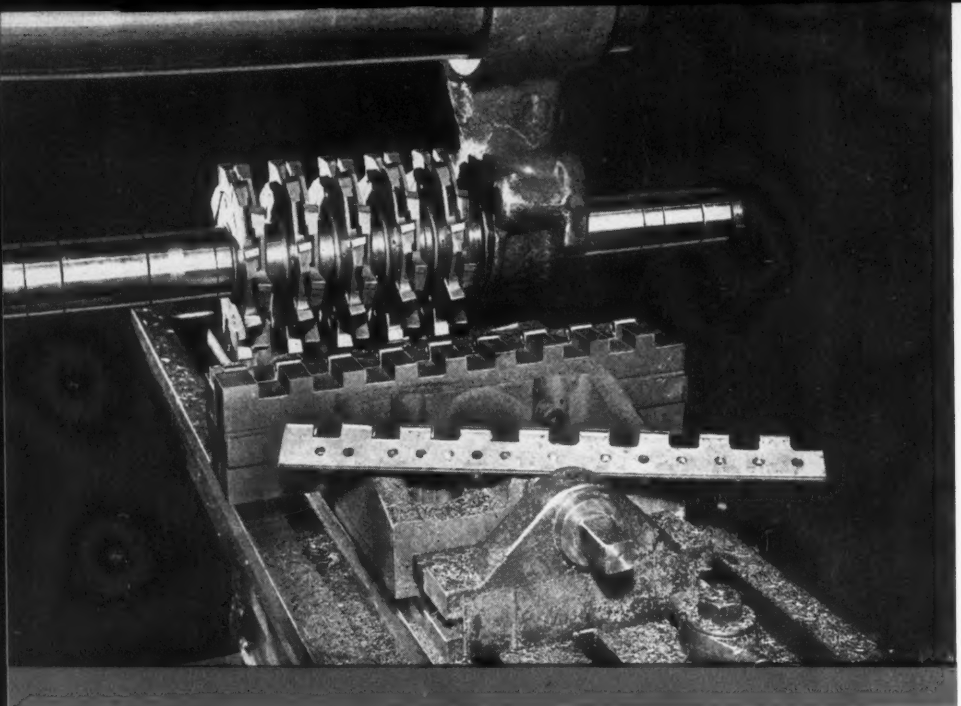


Fig. 19. Gang-milling Operation in which Ten Interlocking Cutters of the Negative-rake Negative-helix Type are Used in Pairs for Finishing Chromium-molybdenum Nacelle Hinges

machine, the concentricity of the cutter periphery and the plane of the cutter face are checked with a dial indicator. The total tolerance in either case is held to plus or minus 0.0005 inch. Lockheed experience has been that negative-rake milling cutters make it possible in many cases to produce with one machine and one man as many parts in a day as were formerly turned out by four machines and their operators.

The concentricity of the cutter and the accuracy of the cutting plane have a direct bearing on the number of parts per grind. For example, if any one tooth on a face-mill should extend 0.001 inch higher than the others, that tooth would take a heavier chip load, and paradoxical as it may seem, that tooth would hold up longer than the teeth that are taking lighter chip loads. Evidence is shown that a "chip load," or feed per tooth, of less than 0.003 inch causes excessive wear, regardless of the material being machined.

Negative-rake milling has made it possible to obtain a finished surface in one cut on steel parts that were previously milled and then ground. The high surface speeds used in negative-rake milling, which vary from 500 to 800 feet per minute on S A E 4130 steel in the Lockheed Factory A (formerly Vega) machine shop, do not create excessive heat on the face of the work-piece or on the tip of the cutter. This is because the chip is removed so rapidly that there is no time for the heat developed in the chip to be transferred to either the work-piece or the cutter. After machining, the piece of work is warm, but is not too hot to handle with bare hands.

In order to eliminate vibration, the cutter bodies are made of some such shock-absorbing material as Meehanite, and flywheels are mounted on the cutter-arbor whenever the set-up permits. These flywheels are made up in 80-pound

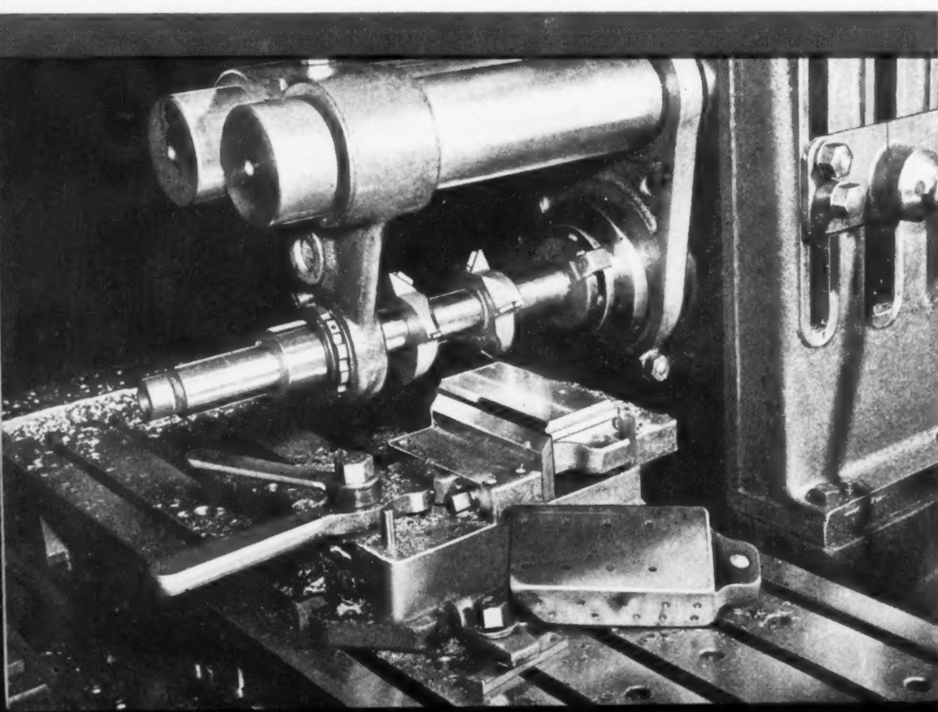


Fig. 20. Chrome-molybdenum Beam Fittings are Finished on the Sides and Bottom and Beveling Cuts Taken along the Edges in 6 Minutes, as against About 1 3/4 Hours with High-speed Steel Cutters

Fig. 21. Milling Beveled Corners on Lift Lugs with a Table Feed of 10 1/2 Inches per Minute, the Maximum Depth of Cut Being 11/16 Inch. Two Lugs are Milled Simultaneously

weights, and as many as three flywheels are mounted on one arbor. The flywheels, of course, also make it possible for cuts to be taken that would otherwise necessitate motors of greater power. Most Lockheed (Factory A) cutters are made with a negative rake of 10 degrees, and all of them with a helix angle of 10 degrees. As in other shops, it has been found that the greater the negative rake, the greater the horsepower requirements. Changes in the helix angle do not affect horsepower requirements appreciably.

Details of milling operations in Lockheed shops performed with negative-rake cutters will be of interest to engineers planning to adopt the new cutting method. In Fig. 16 is shown an operation which consists of milling S A E 4130 chromium-molybdenum steel forgings having a hardness of 205 Brinell. The 10-inch diameter cutter is 2 1/2 inches thick and has twelve tips of Kennametal. The cutter blades are set to a negative rake angle of 10 degrees and a negative helix angle of 10 degrees. The machine is a Milwaukee vertical miller driven by a 10-H.P. motor.

With a cutter speed of 247 R.P.M., which gave a peripheral cutting speed of 647 feet per minute, and a table feed of 12 1/2 inches per minute (or a feed per cutter tooth of 0.004 inch), a production of 10 parts per hour was obtained. The parts are milled at two different heights, and the depth of cut in each instance is 0.125 inch. Sixty pieces are finished between grinds. With the speeds and feeds mentioned, the motor was considerably overloaded.

On a test run, the spindle speed was increased to 1000 R.P.M., or 2620 surface feet per minute, and the table feed was stepped up to 60 inches per minute. This gave a "chip load" of 0.005 inch per tooth. The depth of cut was the same as before. With these extreme speed and feed

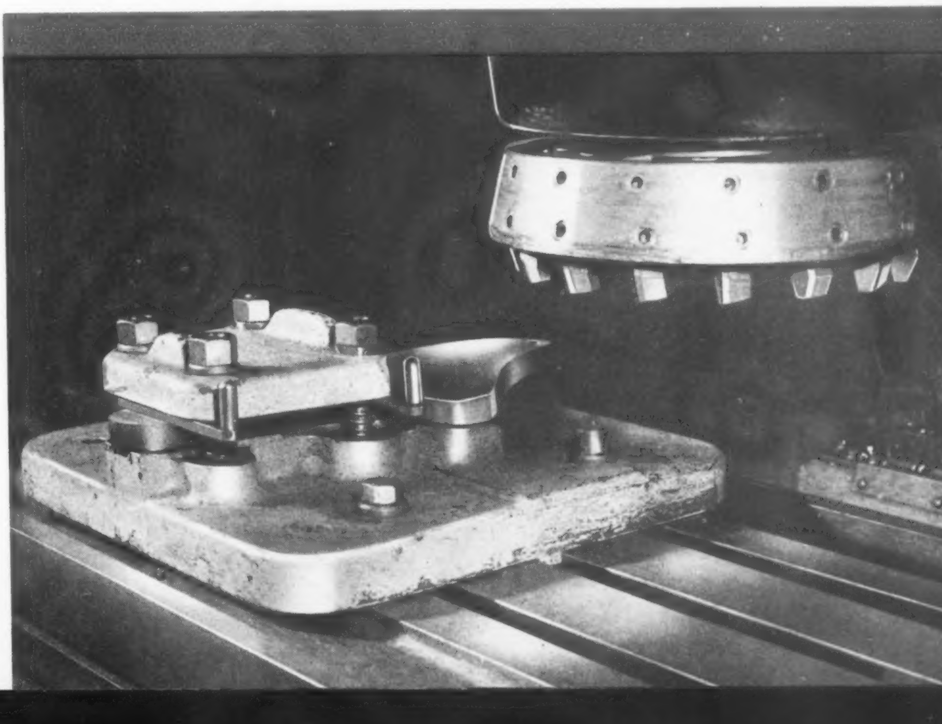


Fig. 22. Terminal Plates of S A E 4130 Steel are Milled in a Douglas Plant with Table Feeds as High as 17 Inches per Minute by Applying the Negative-rake Cutter Here Shown, the Depth of Cut being 3/8 inch

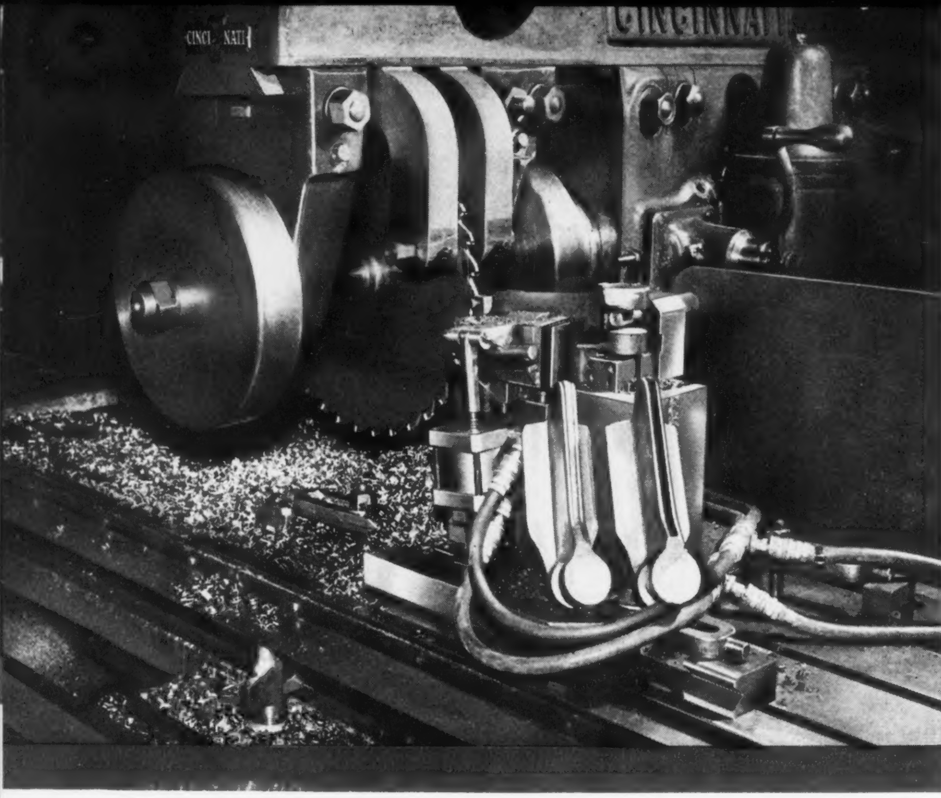


Fig. 23. Slitting Saw with Teeth of Neutral Rake and Negative Helix, which has Reduced the Time on a Slotting Job from 75 Minutes per Piece to 1 Minute

rates, the production was increased to 40 pieces an hour, but only 12 pieces were milled between grinds.

The large cutter body provided a sufficient flywheel effect for smooth operation. It was found that there was less damaging effect on the cutter-spindle from the impact blows of the teeth at the higher speed than at the lower speed. However, the motor was overloaded approximately 80 per cent. The operation was performed on the conventional milling principle rather than by climb-cutting.

Fig. 18 shows the same cutter mounted on another Milwaukee vertical milling machine for milling four bosses 1 3/8 inches in diameter on a forging of S A E 4130 chromium-molybdenum steel. These parts have a hardness of 210 Brinell. The cutter is made with twelve teeth, it being common Lockheed design to make the number of teeth two more than the cutter diameter, as already mentioned. Both the rake and helix angles are 10 degrees negative and the tips are Kennametal. In the operation shown, the spindle speed is 247 R.P.M., and the table feed is 17 1/2 inches per minute, which gives a feed of 0.006 inch per tooth. The depth of cut is 3/16 inch. Application of a negative-rake milling cutter for this job has resulted in a production increase of 200 per cent over the output obtained with a high-speed steel cutter.

A cutter set-up for milling the yoke on shock strut fittings is shown in Fig. 17. Four cutters 8 inches in diameter, having ten teeth set at negative rake and helix angles of 10 degrees, are used. The surfaces machined are approximately 2 by 1 3/4 inches, and stock is removed to a depth of 3/32 inch. Attention is called to the two flywheels on the arbor. In this operation, the cutter runs at 230 R.P.M., which gives a surface cutting speed of 481 feet per minute.

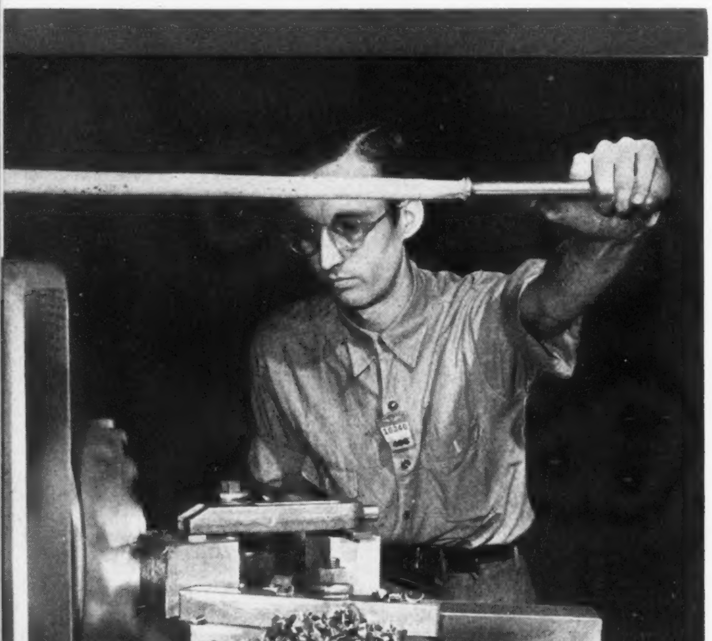


Fig. 24. Two Hundred Blocks of Chromium-molybdenum Steel, 6 1/2 Inches Long by 3 1/2 Inches Square, are Finished All over per Grind of the 12-inch Negative-rake Negative-helix Cutter

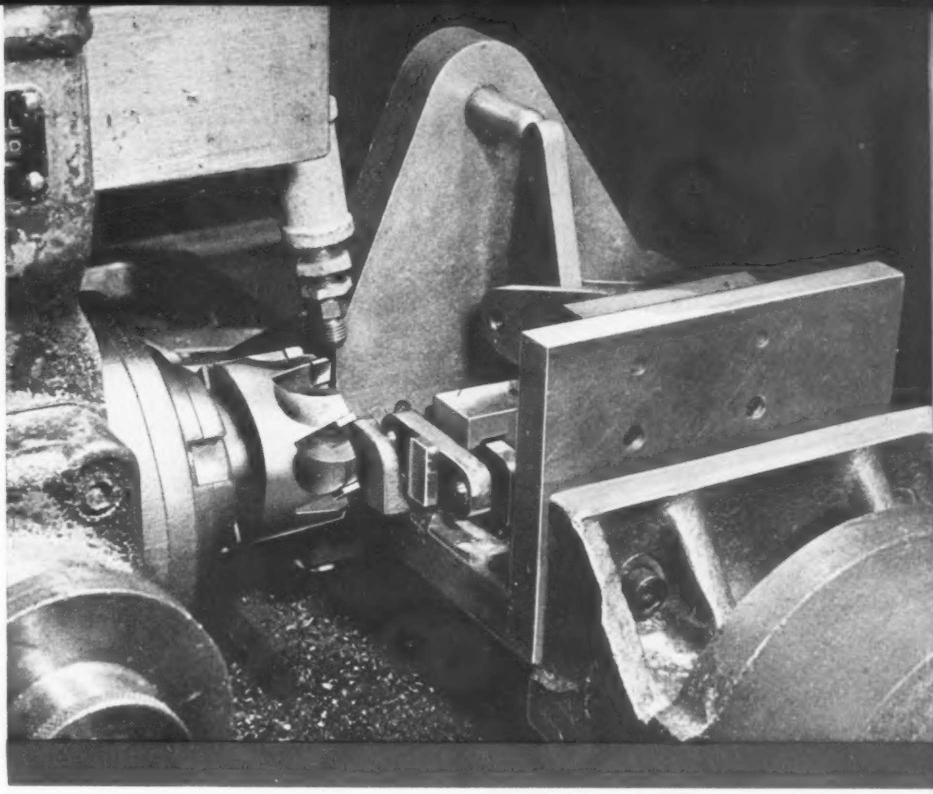


Fig. 25. Milling Malleable-iron Castings with a Table Feed of 35 Inches per Minute and a Cutter Operating at a Speed of 300 Surface Feet per Minute

The feed is 6.9 inches per minute, which gives a feed per tooth of 0.003 inch.

A multiple operation in which five pairs of interlocking cutters are applied simultaneously is illustrated in Fig. 19. The operation consists of finishing lugs on nacelle hinges and the surface of the strip metal between the lugs. Since this photograph was taken, the machine has been tooled up with nine pairs of cutters for finishing all the lugs at one time. The 6-inch eight-tooth cutters are run at 355 R.P.M., and the table feed is 7 5/8 inches a minute. Stock is cut to a depth of 1/16 inch on all surfaces. The material is 3/32-inch strip S A E 4130 steel.

The bottom and both sides of chromium-molybdenum beam fittings, such as seen on the table of the Milwaukee milling machine in Fig. 20, are finished by negative-rake milling cutters, although the illustration merely shows the set-up employed in milling a bevel along the two sides. The total time for machining all the surfaces mentioned is only six minutes, as against approximately 1 3/4 hours when high-speed steel cutters were used. The beveling operation shown, in which the maximum depth of cut is 1/4 inch, takes one minute. The 4-inch cutters are made with only four teeth. They are run at 514 R.P.M. and the table feed is 11 inches per minute. The "chip load," or feed per cutter tooth, is 0.005 inch.

In the operation illustrated in Fig. 21, the cutter is bolted directly to the spindle nose. For set-ups like this, the milling machine could well be built with a flywheel on the spindle within the column, as close to the front wall as possible. In this operation, corners on lift lugs of S A E 4130 steel are cut away to an angle of 45 degrees. The maximum depth of cut is 11/16 inch. Both lugs on the part are milled at one time, and after the lugs have been machined on

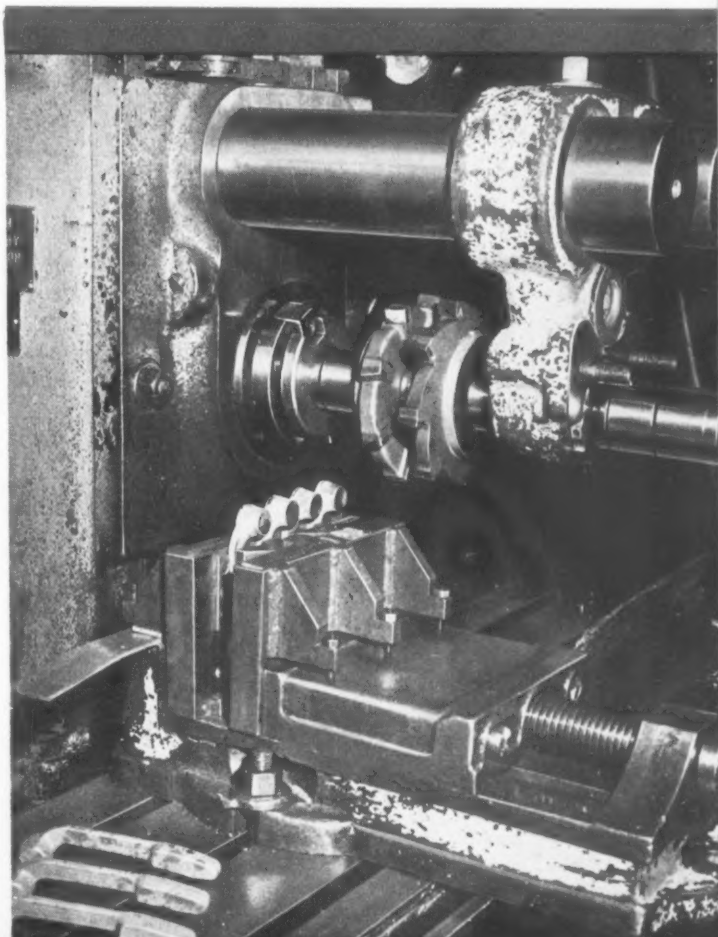


Fig. 26. Finishing Bosses on Chromium-molybdenum Steel Forgings with Two 6-inch Side-milling Cutters. The Cutters Run at 400 R.P.M., and the Table Feed is 15 Inches per Minute

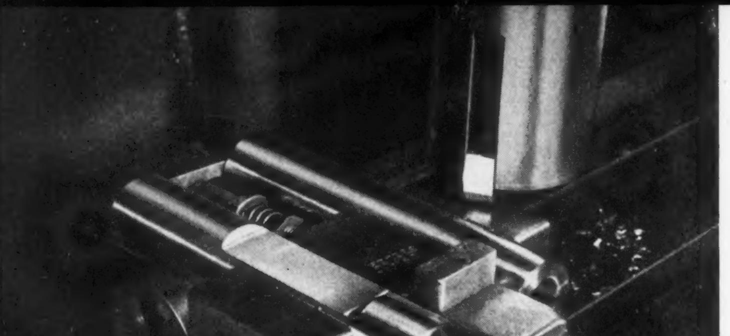


Fig. 27. Machining Lock-pins of Heat-treated Chromium-molybdenum Steel with a Single Negative-rake Fly Cutter Running at 225 Surface Feet per Minute

one side the parts are reversed in the fixture for machining the opposite side. The 6-inch eight-tooth cutter is driven at 365 R.P.M., and the table feed is 10 1/2 inches per minute.

A remarkable sawing operation in which a slitting cutter 16 1/2 inches in diameter constructed of boiler plate and thirty-six Kennametal tips is run at a peripheral speed of 583 feet per minute is illustrated in Fig. 23. The teeth of this saw are ground without any rake at all, but they are staggered and set to a negative helix angle of 5 degrees. The saw cuts a slot 0.340 inch wide by 5 3/4 inches long to a depth of 2 1/2 inches through wing fittings of S A E 4140 steel. These fittings have a hardness of 248 Brinell.

It takes only 47 seconds for the cut and 10 seconds for reloading, so that the floor-to-floor time is less than 1 minute per piece. With a high-speed steel saw, the time per piece was 75 minutes. In order to obtain this high production, the machine was equipped with an air-operated fixture. Plastic guides held in brackets attached to the over-arm support both sides of the saw near the teeth to prevent excessive vibration in a lateral direction. Two heavy fly-wheels are provided on the cutter-arbor.

It is the opinion of Lockheed engineers that considerable experimentation and research are necessary to provide satisfactory answers to questions concerning proper machine tool and cutter construction for negative-rake milling; correct tip metal composition for the various materials machined; preferable cutting speeds and feeds; and the most efficient rake and helix angles.

The construction of a typical Lockheed staggered-tooth negative-rake cutter is illustrated in Fig. 7. It will be seen that the peripheral edge of each tip is provided with a primary clearance of 2 degrees for a land 1/32 inch wide, and with a secondary clearance of 7 degrees. A Lockheed end-mill of 1 1/2 inches diameter made with two carbide tips having 10-degree negative-rake and negative-helix angles is illustrated in Fig. 8.

Negative-Rake Milling in Douglas and Other Plants

An outstanding job in the Long Beach plant of the Douglas Aircraft Co., Inc., consists of milling terminal plates of S A E 4130 steel, heat-treated to 370 Rockwell, with the set-up illustrated in Fig. 22. This inserted-blade milling cutter is 10 inches in diameter, and is run at 130 R.P.M., giving a peripheral cutting speed of 340 feet per minute. The table feed is varied from 12 to 17 inches per minute, and the depth of cut from 0.320 to 0.350 inch. The cutter has sixteen inserted carbide-tipped blades, which are set at a negative-rake angle of 6 degrees and a negative-helix angle of 10 degrees. The blade shanks are well supported in a heavy cutter body, bolted directly to the spindle nose.

In Fig. 24 is shown an operation performed in the Santa Monica plant of the concern, which consists of milling blocks of S A E 4130 steel, 6 1/2 inches long by 3 1/2 inches square, on all surfaces. The 12-inch solid type cutter has fourteen teeth, and has been run at various speeds from 136 to 202 R.P.M. The table feed at the lowest spindle speed is 10 1/2 inches per minute, and at the highest 12 1/2 inches per minute. In this operation, 200 pieces are machined between regrinds of the cutter. When this operation was performed with high-speed steel cutters, the production averaged 40 pieces between grinds, and the table feed was only 2 1/2 inches per minute.

Another operation in the same plant (shown in Fig. 26) consists of milling clevises from S A E 4130 steel. Two side-milling cutters are used for straddle-milling opposite sides of the bosses. These cutters are 6 inches in diameter and have eight teeth. They are run at about 400 R.P.M., and the work is fed to them at the rate of 15 inches a minute. The depth of cut on each side of the bosses is 1/8 inch. These cut-

ters, as well as the one shown in Fig. 24, are known as "Cal-Cutters," and are made by the Machinery Mfg. Co.

The heading illustration and Fig. 1 show a negative-rake milling cutter of the inserted-blade type being used on a Giddings & Lewis horizontal boring, drilling, and milling machine in the shop of the Joshua Hendy Iron Works, Sunnyvale, Calif. The cutter has fifteen Firthite T-16 teeth. It is shown taking a 3/8-inch deep cut on a connecting-rod for a reciprocating steam engine.

The cutter, which is 10 inches in diameter, is run at 220 R.P.M., and the feed per cutter tooth is 0.004 inch. The material is S A E 1030 steel. The close-up view in the heading illustration clearly shows the cutter design and the type of chips obtained. Only two minutes is required for taking a cut across the connecting-rod, whereas the time was thirty minutes with a 5-inch diameter high-speed steel cutter.

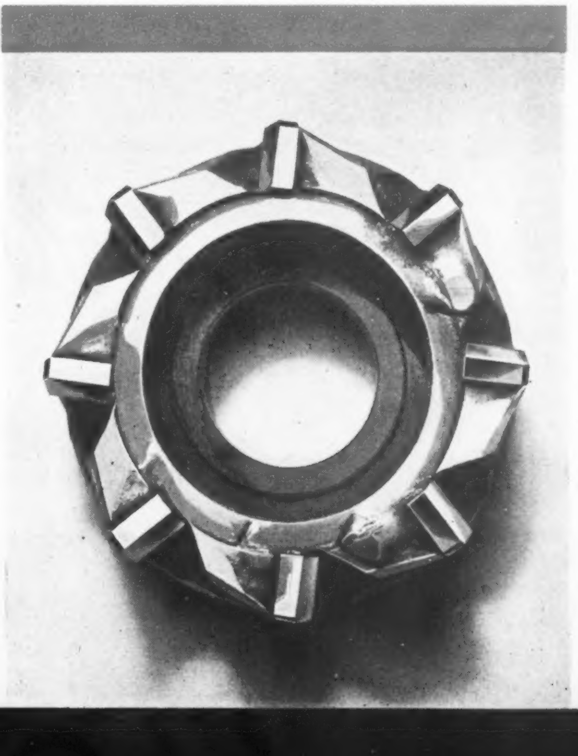
An operation in the Consolidated-Vultee plant at Vultee Field, Calif., which is being performed almost twenty times faster by the use of a negative-rake carbide-tipped milling cutter than with the high-speed steel cutter formerly used, is illustrated in Fig. 25. The work-piece is a rib attachment fitting for a basic trainer airplane. This part was formerly made of aluminum, but malleable iron was used when a material substitution program was inaugurated to divert all the aluminum possible to combat craft. The negative-rake cutter was adopted when high-speed steel cutters failed to keep up with assembly line demands.

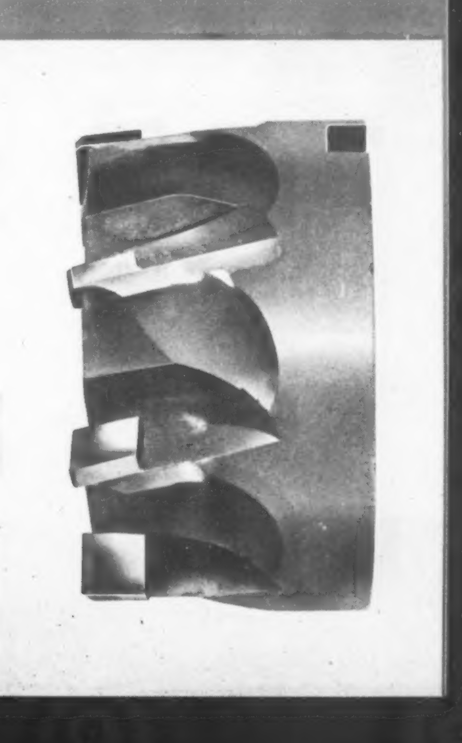
The negative-rake cutter is 2 5/8 inches in diameter, and is made with eight teeth having 5 degrees negative rake and a 15-degree negative helix angle. The carbide tips are ground to a 1/16-inch chamfer on the corners. The cutter is run at 440 R.P.M., and the table feed is 35 inches a minute, the depth of cut being 1/8 inch. The cutter body is cold-rolled steel, and the carbide tips are Carboloy. Figs. 28 and 29 clearly show the cutter construction.

Single fly cutters of negative rake are used to some extent in the plant of North American Aviation, Inc., Inglewood, Calif., for milling steel parts. Fig. 27 illustrates an operation of this type on landing-gear lock-pins of heat-treated chromium-molybdenum steel having a tensile strength of between 160,000 and 180,000 pounds per square inch. The cutter is 2 3/4 inches in diameter, and is being run at a speed of 318 R.P.M. The maximum depth of cut is 3/16 inch, and the feed is 1 1/2 inches per minute. This cutter has a negative rake of between 2 and 3 degrees and a negative helix angle of 3 degrees. Previously a cutter with a negative rake of 10 degrees was used for this operation. That cutter was run at a speed of 1000 R.P.M. and cut to a depth of 1/4 inch. The work was fed at the rate of 9 inches a minute.

Negative-rake carbide-tipped fly cutters are used extensively in the same shop for machining aluminum castings and bar stock.

Figs. 28 and 29. Milling Cutter 2 5/8 Inches in Diameter Made with a Negative Rake of 5 Degrees and a Negative Helix Angle of 15 Degrees for the Operation Illustrated in Fig. 25





Precision Thread Rolling with Flat and Cylindrical Dies

Large Quantities of Screws and Studs are being Thread-Rolled to Meet the Exacting Standards of the Aircraft-Engine Industry. High Production, Increased Tensile Strength, and Superior Surface Finish are Advantages of This Process

By HOLBROOK L. HORTON

THE forming of screw threads by rolling has been practiced for over one hundred years. Patents on thread-rolling machines go back at least to 1860, and there is a model of a thread-rolling machine in London dated 1851 that utilizes the same principles as machines of today. There was a great deal of development in this field between 1860 and 1890. Then for more than a generation little was done to improve the process, and considerable prejudice arose against it as a possible method for precise screw thread forming.

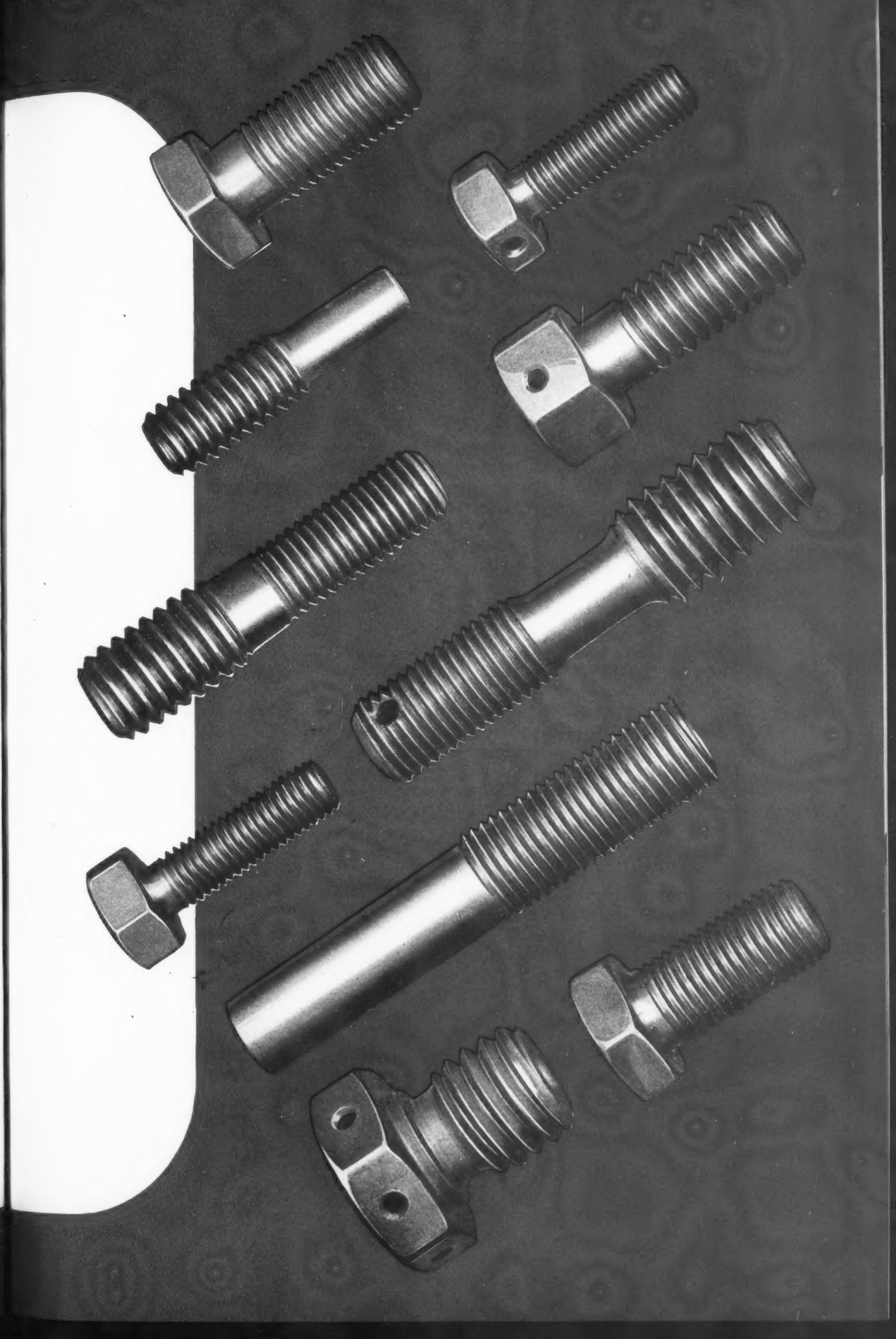
One reason for this was that in the early days of thread rolling the dies were customarily made by hand in the tool-rooms of the user. They were difficult to make accurately, and were usually suitable only for turning out comparatively rough work, such as wood screws or bolts and studs for ordinary use. Then precision dies gradually became available, and during the late 1920's and early 1930's thread rolling was adopted by several automobile companies to turn out bolts, studs, and screws of high quality. Now the process is being utilized by the aircraft-engine industry for making precision threaded parts in considerable quantities.

This achievement has been the result of a great deal of study and research directed to the improvement of the flat-die thread-rolling process and the development of cylindrical-die thread-rolling methods, as well as the manufacture of accurate dies that would meet the requirements of precision work. These dies, such as are shown in Figs. 1, 2, and 3, are now machined to very close limits, are lapped or ground to a high finish, and are made of alloy or high-speed tool steel.

Some manufacturers have equipped their machines with adjustments for accurately spacing the dies and placing them in the exact alignment necessary, and others are making improvements in this direction. The result of these forward steps has been that threads of sufficient accuracy to meet the exacting standards of the aviation industry are now being produced on several different types of thread-rolling machines.

Two distinct methods of thread-rolling are employed. In the older and more commonly used of these, the blank to be threaded is rolled between two flat, hardened steel dies. Each of these dies has cut into its face a series of ridges and grooves which are, in effect, the negative profile of the thread to be formed, having the same pitch and helix angle. When the blank is rolled between them, this thread profile is impressed into its surface. This is the process that has been used for many years to turn out wood screws and commercial bolts in quantities ranging up to 175 per minute.

The improvement of this process has been effected in two ways. The dies now employed are milled and lapped to accurate pitch and thread form and a high surface finish; the work blanks are centerless-ground to close limits. With this combination of accurate dies and blanks, it is possible to roll screws, studs, and other threaded parts that meet the requirements of Class 3 and Class 4 fits.



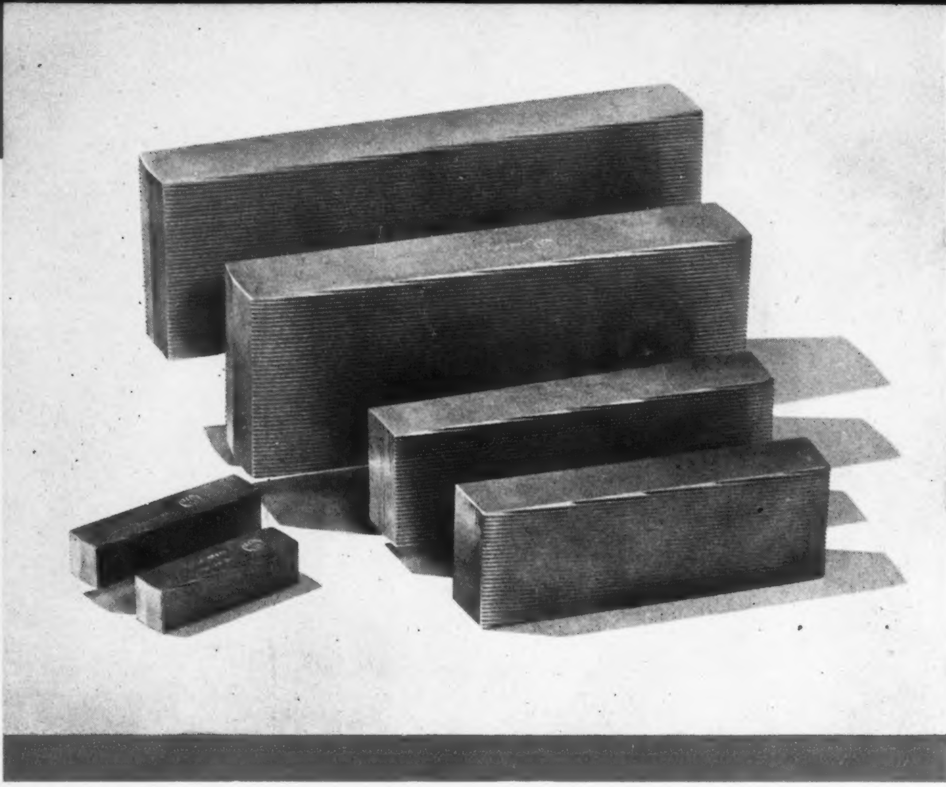


Fig. 1. Six Sizes of Flat Dies Employed for Thread Rolling. The Two Smallest and the Two Largest are Duplex Dies, Each having an Alternate Working Face. The Two Intermediate Dies have One Working Face

There are several types of flat-die thread-rolling machines being manufactured by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.; National Machinery Co., Tiffin, Ohio; E. J. Manville Machine Co., Waterbury, Conn.; and National Electric Welding Machines Co., Bay City, Mich. Two types of these machines are shown in Figs. 4 and 6.

In the other, more recently perfected method, thread rolling is accomplished by means of cylindrical dies. These cylindrical dies have on their faces negative multiple threads of the same profile, pitch, and helix angle as the thread to be rolled. They are usually thread-ground to close tolerances and have a high surface finish. The diameter of these cylindrical dies is always an exact multiple of the pitch diameter of the finished work-piece, and the number of thread starts on the dies is a multiple of those to be formed on the work. As in the case of the flat-die process, the entire threaded length of the work-piece is formed at one time.

Two types of machines utilize cylindrical dies for thread rolling. In one, Fig. 5, manufactured by the Watson-Flagg Machine Co. (W. A. Schuyler, agent, New York City), two cylindrical dies are employed; in the other, Fig. 7, known as the Reed, and built by the Rolled Thread & Die Co., Worcester, Mass., three are used.

The application of the thread-rolling process to precision work was, until the time of its adoption by the aircraft-engine industry, pretty much limited to the threading of taps and micrometer spindles. Now, however, all the studs from No. 8 to 1/2 inch diameter for one of the large aircraft engines are threaded by rolling, and the process is being widely used throughout the aircraft-engine industry.

Representative aircraft-engine screws and studs that have been thread-rolled are shown in Fig. 10. Aircraft-engine studs are being rolled in steel having a hardness ranging up to 32 Rockwell C and beyond. The tensile strength of this material is 140,000 to 150,000 pounds per square inch, as compared with 60,000 to 70,000 pounds per square inch for ordinary screw stock.

Both flat-die and cylindrical-die machines are being utilized by the Wright Aeronautical Corporation for a variety of thread-rolling operations using steel blanks in the hardness range of 26 to 32 Rockwell C. The rolling of blanks of even greater hardness is in immediate prospect.

Preparatory to thread rolling in this aeronautical plant, the blanks are centerless-ground in two operations. In the first operation, the blank is ground to a diameter 0.003 inch larger than its final diameter. In the second operation, the diameter of the blank is ground to within a minus 0.0003-inch tolerance. A spot check of the finished ground blanks is made about every fifty pieces as they come out of the machine to maintain control of the grinding operation. A 100 per cent check is made of the blank diameters just before thread rolling.

It may be mentioned here that since thread rolling does not remove any metal the blank diameters must be held within limits that are as close as or closer than those allowed on the finished screws. One thread-rolling machine manufacturer recommends a tolerance on the

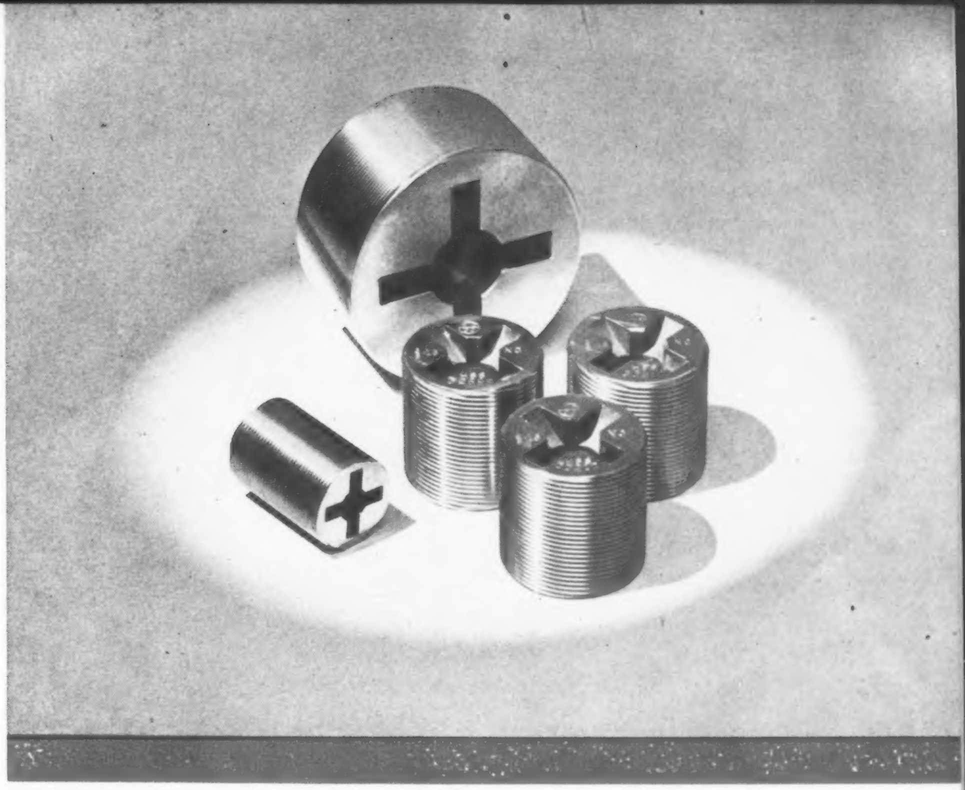


Fig. 2. Several Sizes of Cylindrical Dies Such as Used in Reed Machine. The Three Vertical Dies are Shown in Their Relative Working Positions. The Blank is Inserted Vertically between Them

blank diameter of about two-thirds that required on the final thread diameter.

It should be noted that the size of the blank must be smaller than the final major diameter of the thread, since metal is forced outward during the rolling process to form the thread crests. The proper blank diameter is usually equal to the pitch diameter of the finished thread, or it may be slightly larger, depending upon the pitch of the thread and the material to be rolled. When it is undesirable for the rolled-thread major diameter to be larger than the shank of the threaded piece, that portion of the blank to be thread-rolled can be extruded or ground to a smaller diameter than the shank.

Both the Watson-Flagg and the Reed cylindrical-die thread-rolling machines have been installed in one Wright Aeronautical plant. They are being used for turning out close fitting studs having a lead end, that is, a threaded portion at the end of the stud which is of smaller diameter than the remainder of the stud. This lead end facilitates the insertion and starting of the studs, since a driven fit is specified. The raised portion of the face of the cylindrical die which forms the lead end is placed in the middle of each roll, and the rolls are made long enough so that only one half of each is in use at any time. At the end of the working life of one half, the die is reversed and the other half used.

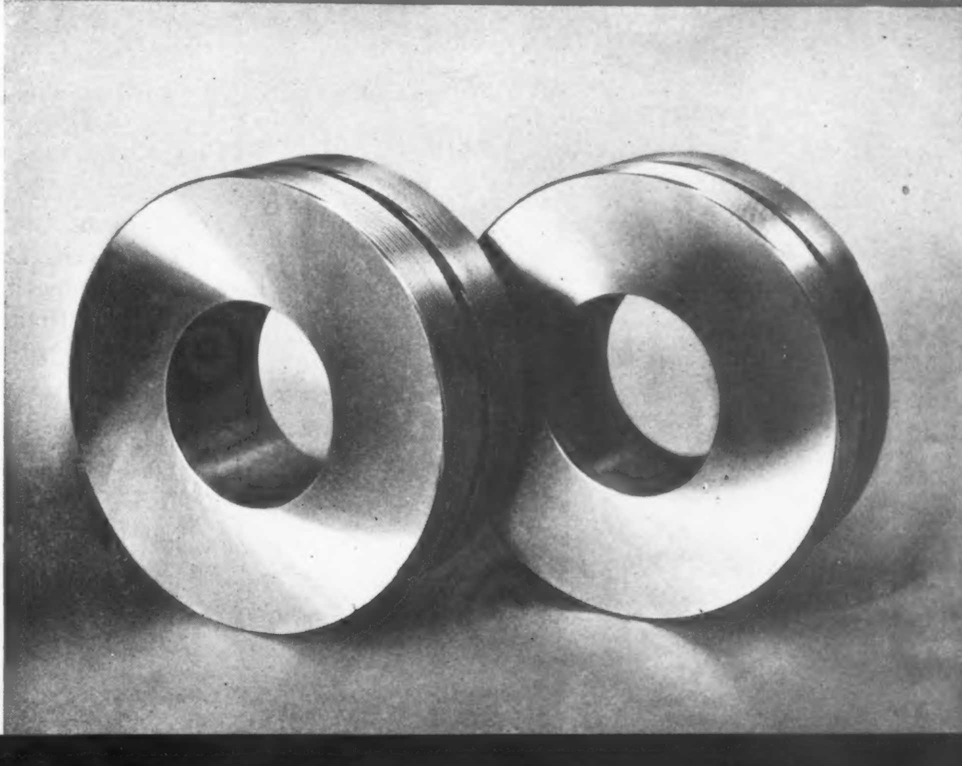


Fig. 3. Large Thread-forming Rolls of the Type Used in Watson-Flagg Machine. The Diameter of These Dies is Always a Multiple of the Work-piece Pitch Diameter. The Work-piece is Supported Horizontally between the Two Rolls

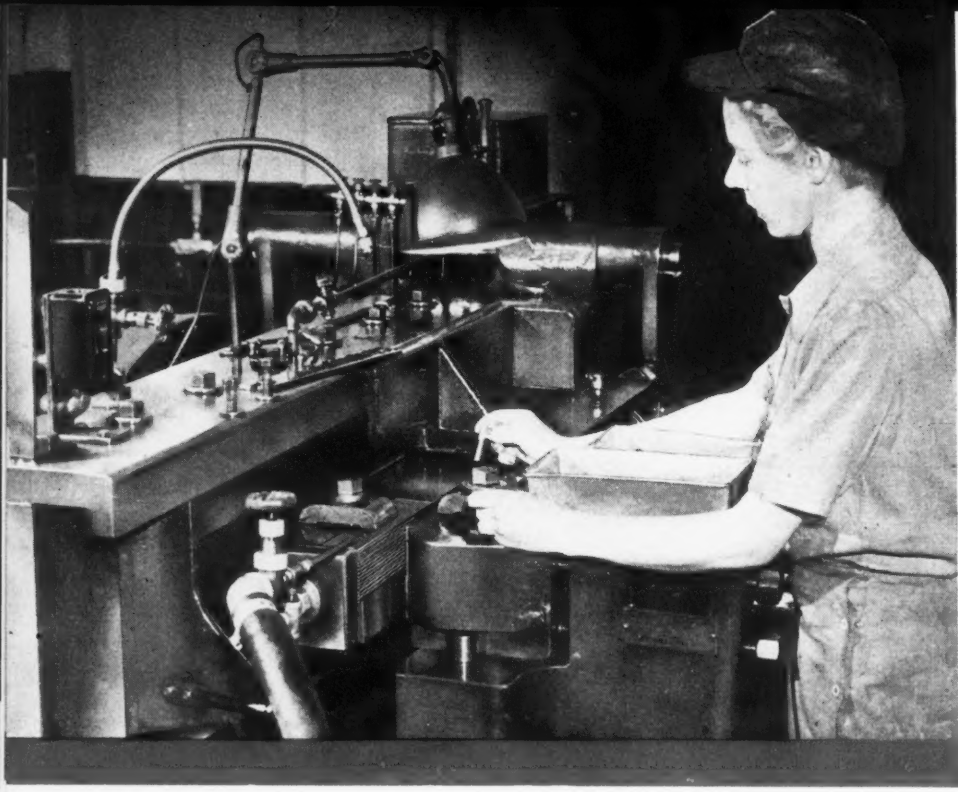


Fig. 4. Horizontal Hand-fed Flat-die Thread-rolling Machine. Two Dies are Used. One is Held Stationary while the Other Reciprocates. The Working Face of the Latter is Clearly Seen

On these cylindrical-die thread-rolling machines a pitch diameter of within 0.001 inch, concentricity within 0.0004 inch, and Class 3 and 4 fits on pitch and lead are being obtained. Hollow work-pieces are also being thread-rolled at the Wright plant within close tolerances on these machines.

Several sizes of Waterbury-Farrel reciprocating flat-die machines are also being used in this plant. Class 3 and Class 4 fit requirements are being met with these machines. The rates of production are as follows: For screws and studs up to 5/16 – 24 size, about 25 to 35 per minute; for the 7/16 – 20 size, about 20 per minute; and for the 7/16 – 14 and 1/2 – 13 sizes, about 12 to 15 per minute.

Thread rolling is essentially a cold-forging operation in which metal is displaced rather than removed. As the blank is rolled between the dies, the ridges on the surfaces of the dies are forced into the blank approximately one-half their depth, forming the roots of the screw thread. At the same time, metal is forced up into the spaces of the die to form the crests of the screw thread. The resulting increase in diameter of the work-piece is clearly shown in Fig. 13.

This process has certain advantages. As shown by Figs. 8 and 9, the fibers of the blank, instead of remaining straight and parallel to the axis in the thread sections—as is the case when the thread is formed by a cutting process, such as milling or grinding—are compressed and curved to conform with the contour of the thread. This cold-working results in greater tensile strength, shear strength, and resistance to fatigue than is obtained when the thread is formed by cutting. On straight tension loads,

Fig. 5. Cylindrical-die Machine in which Two Large Vertical Thread-forming Rolls are Employed. The Right-hand Roll is Fed to the Left toward the Work. An Electro-limit Switch Controls Its Travel

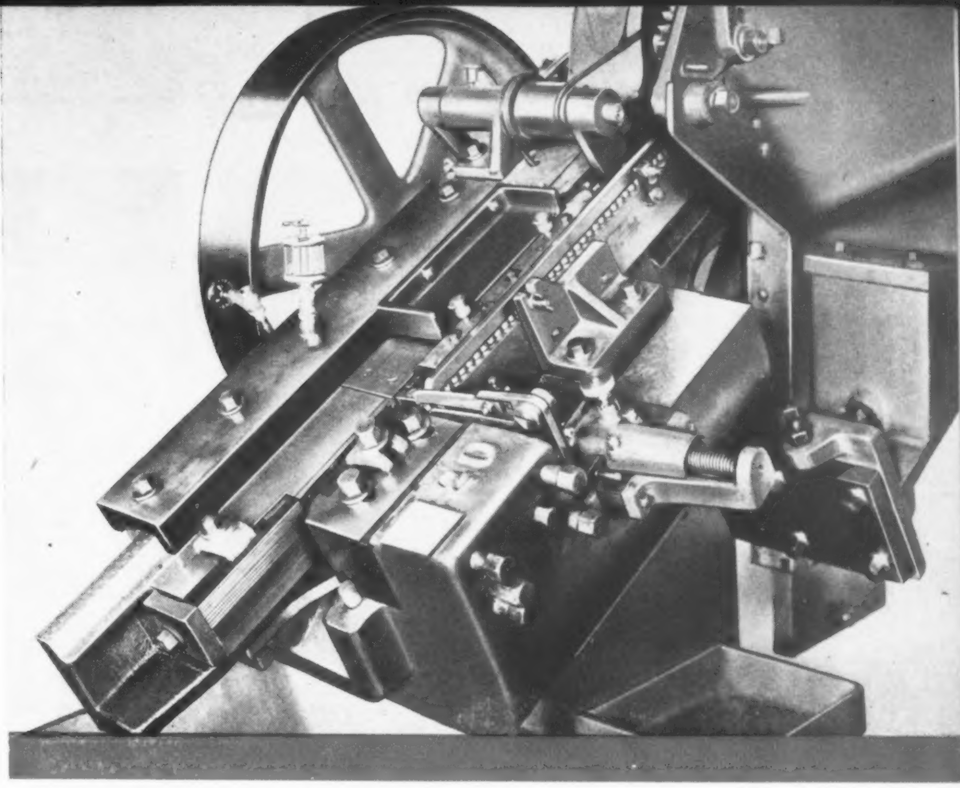


Fig. 6. Inclined Magazine-feed Flat-die Type Thread-rolling Machine. Accurately Threaded Parts are Turned out by These Flat-die Type Machines at a High Rate of Production

rolled threads have shown an appreciable increase in strength over cut threads; and where fatigue loads are involved, this increase in tensile strength has ranged up to 25 per cent. The elimination of exposed shear planes in the thread form results in increased resistance to stripping and other shear failures.

Another advantage of the thread-rolling method is the smooth, hard, burnished surface produced. This is obtained by seeing to it that the surfaces of the dies are extremely smooth, since, as in all cold-forming operations, the surface produced on the threaded section is a replica of the surface finish of the dies.

Soft materials, such as dead soft steel wire and soft non-ferrous metals, which are difficult to cut without tearing, can be rolled as smoothly as the freer machining steels. Smooth surfaces can also be obtained on hard materials, such as heat-treated alloy steels with hardnesses ranging up to Rockwell C 35.

Since the action of the die is one of rolling rather than of cutting, erosion of the die face does not take place; wear is extremely slight; and die failure occurs eventually by crumbling due to fatigue. This means that the dies have a long life and continue to produce accurate threads up to the time of failure. In the case of flat dies, when localized crumbling does begin to occur, the undamaged sections of the dies will tend to iron out the marks in the blanks caused by the crumbled portions, so that dies often need not be discarded until a large portion of their surface has broken down.

Aside from the fact that erosion does not occur, die life is relatively long in comparison with that of a cutting tool, because the pressure exerted on the work, instead of being concentrated

Fig. 7. Another Type of Cylindrical-die Machine, in which Three Rolls are Used. The Blank is Inserted between the Rolls through an Opening in Top Casing. A Work-holder Facilitates Handling Short Blanks

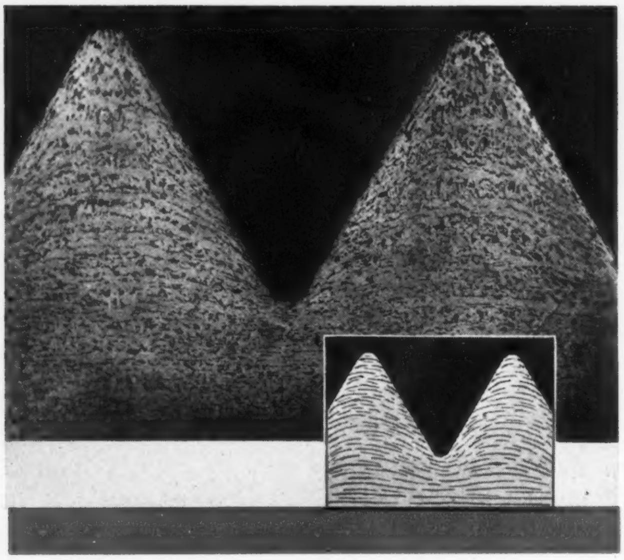


Fig. 8. Photomicrograph Showing how Fibers of Blank that has been Thread-rolled are Compressed and Curved to Conform with Contour of Thread

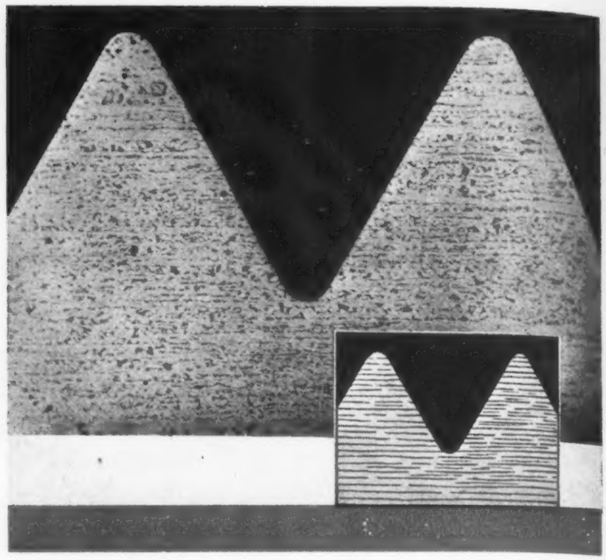


Fig. 9. When the Thread is Formed by a Cutting Process, the Fibers Remain Straight and Parallel with the Axis, Leaving Exposed Shear Planes

on one or more relatively fragile cutting edges, is spread over a wide surface. Thus, thread-rolling dies do not have to be taken out and re-formed or sharpened.

Like every process, however, thread rolling has certain limitations which should be taken into consideration if it is to be utilized to the best advantage. The question is frequently asked: How can thread rolling be used to form an internal thread? A moment's thought will show that the very nature of the process prevents it from being used for this purpose.

With respect to output, at the present time, thread rolling is essentially a high-production process, and is usually not economical where very small quantities are involved. From the standpoint of size, thread-rolling machines are, at the present time, limited to handling blanks in the harder steels of 1-inch diameter or smaller; for softer materials, the blank diameters may range up to 4 inches or more. The working range is determined by the elongation or flow characteristic of the material to be thread-rolled.

The essential parts of a typical thread-rolling

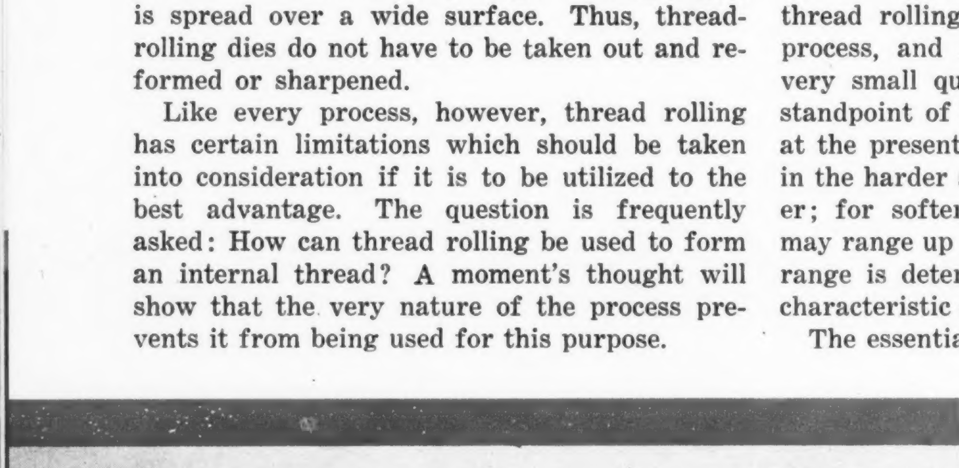


Fig. 10. Various Aircraft Studs and Bolts Turned Out on Cylindrical-die Thread-rolling Machines. These Parts are Made of Nickel, Molybdenum, and Stainless Steels, and Range in Size up to 1 Inch Diameter with an 8-pitch Thread

machine in which flat dies are used are shown in Fig. 15. One die is held in a stationary position, while the other moves on a reciprocating slide. The dies must be so adjusted that at the beginning of the working stroke when the starter finger inserts the work-piece squarely between the dies and underneath a register finger, the tops of the thread-shaped ridges of one die at the point of contact with the blank are directly opposite the bottoms of the thread grooves in the other die.

As the reciprocating slide moves forward, the blank rotates about its own axis and travels at about half the speed of this slide until it clears the end of the stationary die and drops out. In the meantime, another work-piece is made ready at the starting gate to be inserted at the beginning of the next stroke of the slide.

Equipment in which flat dies are used include horizontal machines for hand-fed work; inclined machines with magazine, hopper, or chain feeds; and side-feed machines in which the work is rolled in a horizontal position. The latter type can accommodate much longer pieces than a machine in which the work is located vertically.

The rate of output of these machines depends upon the diameter and the quality of the thread to be rolled. On machines ranging in capacity from 3/32- to 1-inch diameter, the number of strokes per minute is from 30 to 60 on the hand-fed machines, and from 60 to 175 on the automatic machines. For precision work, a rate of around 30 strokes per minute has been found satisfactory on the hand-fed machines. On these reciprocating types of machines a completed

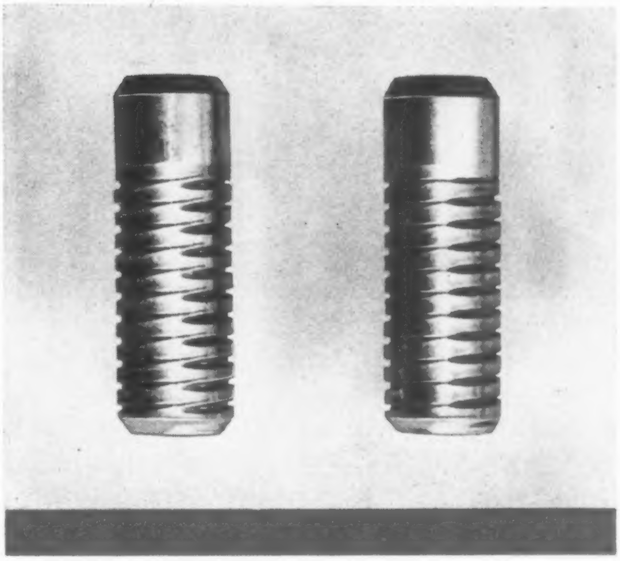
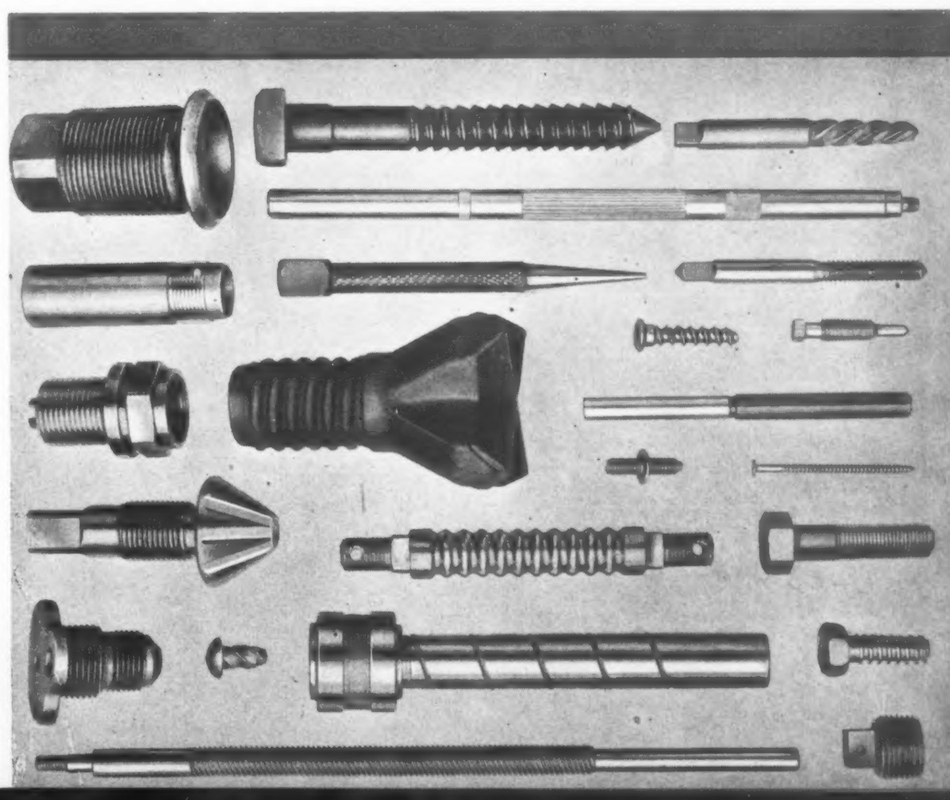


Fig. 11. (Left) Double Thread Impression is Produced by Improperly Located Dies. (Right) If Dies are Properly Matched, Grooves Meet as Shown

work-piece is turned out at each stroke. As shown in Fig. 12, a variety of knurls, grooves, and threads can be rolled on these machines, ranging in accuracy from commercial fastening units to high-precision machine screws.

The sizes of threads rolled on flat-die reciprocating thread-rolling machines usually range from No. 0 to 1-inch diameter, but threads down to 0.006 inch and up to 1.5-inch diameter have been successfully rolled on these machines. Each screw diameter and pitch requires a pair

Fig. 12. A Variety of Knurls, Grooves, and Threads can be Formed on Flat-die Reciprocating Thread-rolling Machines. The Accuracy Obtained Ranges from that of Commercial Fastening Devices to that of High-precision Machine Screws



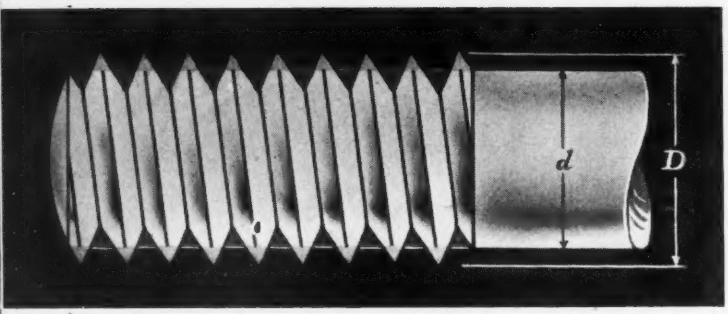


Fig. 13. Comparison of Original Diameter d of Blank and Major Diameter D of Finished Thread Formed by Thread Rolling. The Blank Diameter is Usually Equal to Pitch Diameter of Finished Thread, or Slightly Larger

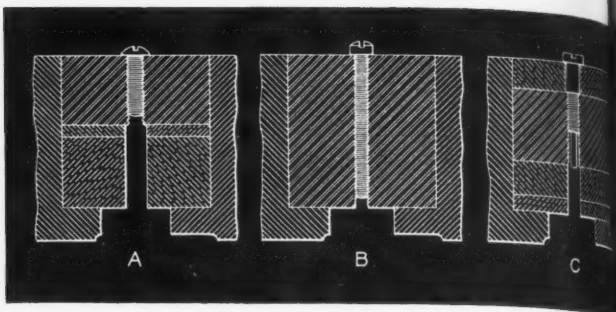


Fig. 14. Filler Plates are Used to Locate Flat Dies in the Proper Position for Various Thread Length Requirements, as Shown at A and C. For a Long Screw as at B, Maximum-depth Dies are Employed

of dies made especially for it. With sufficient care, the pitch diameter of the work-pieces can be held to a tolerance of 0.001 inch and the concentricity to 0.0004 inch, and Class 3 and 4 fit limits met.

The flat dies employed in these machines are usually of a standard depth (depth meaning in this case the width of the die face), although so-called "maximum-depth" dies are employed for long screw threads. To locate the dies in accordance with the requirements of the work, filler plates are inserted above or below them, as shown in Fig. 14. Headless blanks, or those with a length too short or too long for automatic feeding, are effectively located from their ends by means of an adjustable depth gage. These dies are usually of sufficient length so that the blank will make no less than four complete turns during its passage along the die face. For rolling accurate threads in hard material, a minimum of seven turns along the length of the stationary die is recommended.

Either a single or a duplex die can be used. A single die is threaded on one face only, while a duplex die is threaded on both face and back. The advantage of duplex dies is that, after one face becomes unusable, they can be reversed, thus obtaining twice the life of a single-face die.

In the case of both flat- and cylindrical-die machines, the dies must be exactly positioned. The effect of locating the dies improperly, so that they are not in matching position when the work is inserted, is shown at the left in Fig. 11, where it will be seen that a double thread impression results. Even a very slight displacement of the dies from the correct matching position is likely to produce laps or folds of metal on the crests or flanks. When the correct set-

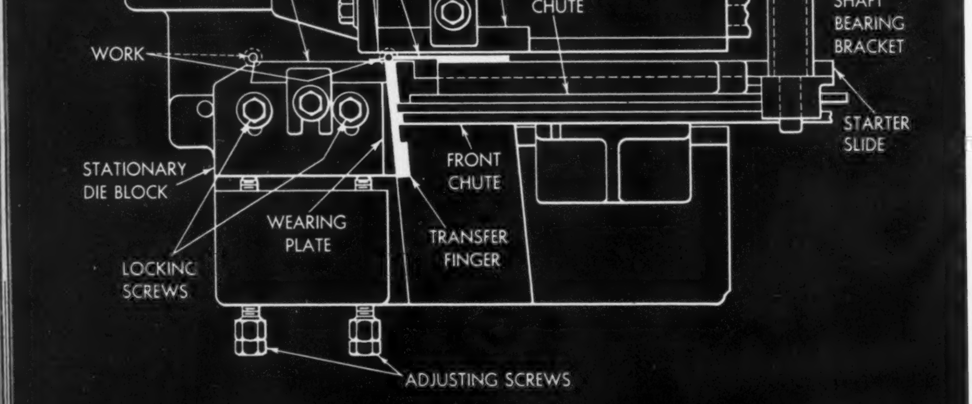


Fig. 15. Essential Features of Reciprocating Flat-die Thread-rolling Machine

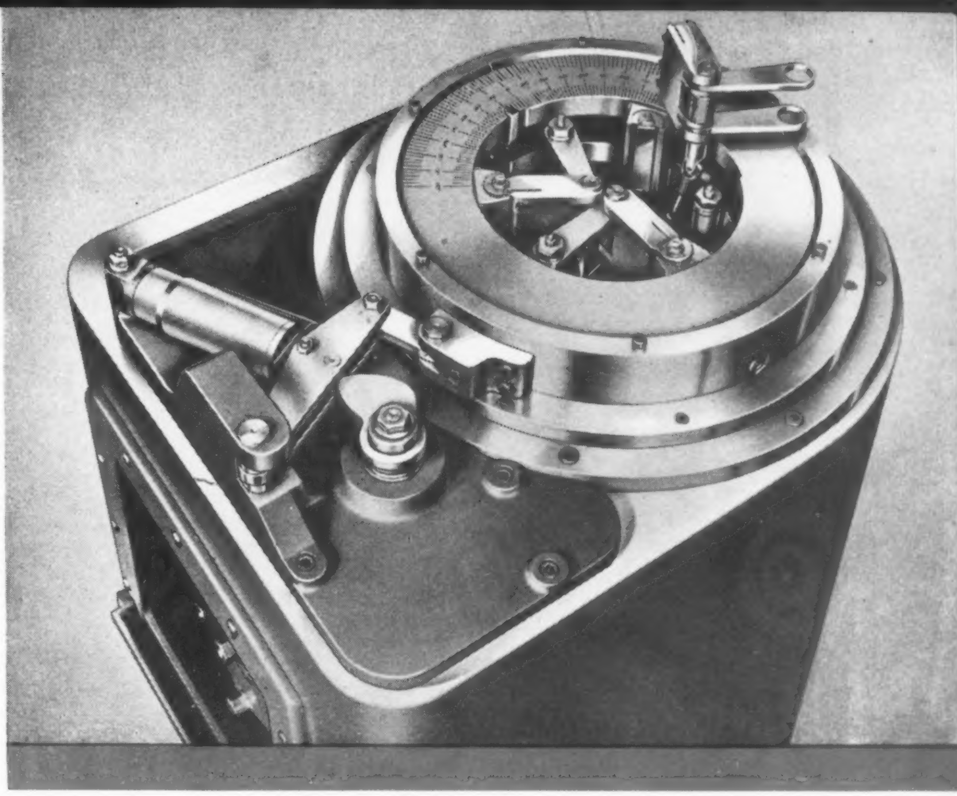


Fig. 16. Reed Cylindrical-die Thread-rolling Machine, Showing Three Toggle Arms on which the Dies are Mounted, and Cam-actuated Die Feeding Mechanism. Work-piece is Held in a Vertical Position

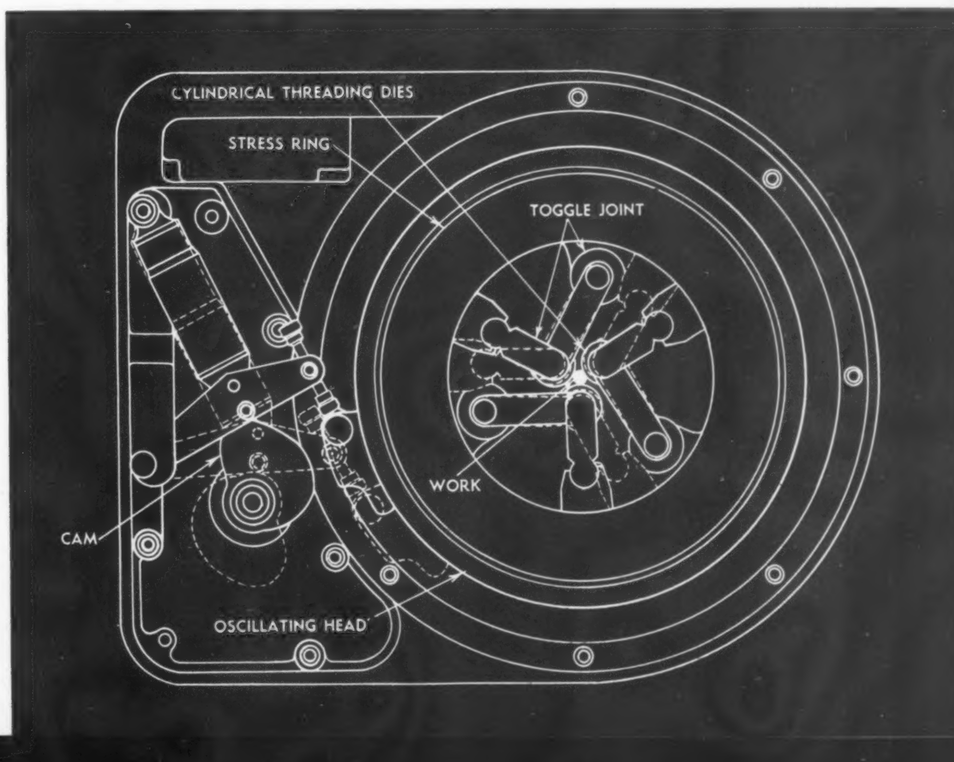
ting is obtained, the first revolution of the blank will produce grooves that match, as shown at the right in Fig. 11.

Turning now to cylindrical-die equipment, the Reed machine, built by the Rolled Thread & Die Co., has rolls that are held in a vertical position. As shown in Figs. 16 and 17, three toggle joints are employed, each of which has an outer member, rigidly clamped to two stress rings, and an inner member, which holds the die and is supported by a guide link and anchor post. As the stress rings are rotated through a short arc, the three cylindrical dies are moved inward into contact with the work, which is held vertically in a floating position between them.

A vertical micrometer type of adjustment of the die-holders on dovetail ways provides for accurate matching of the die threads during the initial set-up. The three die spindles are geared together, so that when the dies are once matched, they will remain that way. The maximum penetration of the dies, which determines the resulting pitch diameter, is controlled by adjusting the position of the stress rings with relation to the supporting oscillating head in accordance with a scale graduated in thousandths of an inch. Adjusting one stress ring in relation to the other controls the taper of the work.

The movement of the dies is governed by cam action, the rotation of the cam, in turn, being controlled by change-gears. By using the proper cam and change-gears, the following variables

Fig. 17. Construction Details of Reed Cylindrical-die Thread-rolling Machine



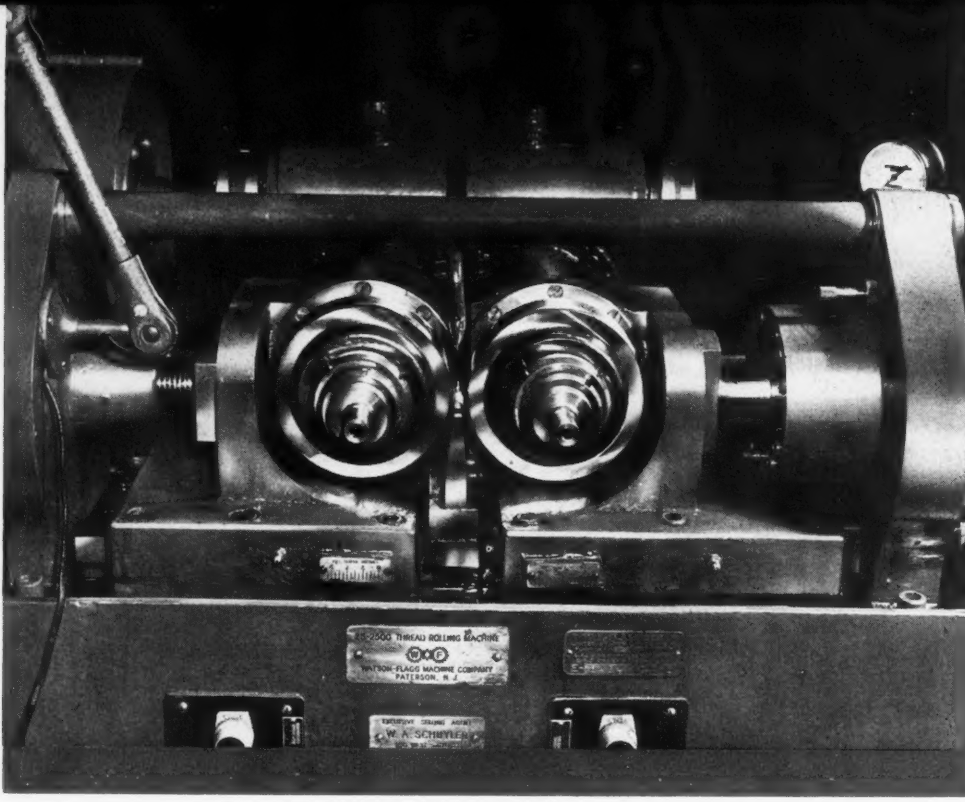


Fig. 18. A Watson-Flagg Cylindrical-die Thread-rolling Machine, Showing Work-piece in Horizontal Position on Center Rest. Right-hand Roll is Fed Hydraulically toward Work

can be adjusted to suit the work at hand: Number of cycles per minute; speed of rotation of dies and work; time for loading and unloading; number of contacts between a given point on the screw thread and the die during the forming of the thread; rate of penetration per contact, which can be made to vary within each cycle if desired; and the amount of dwell at the innermost position of the dies for accurate sizing.

In the Watson-Flagg machine, Fig. 18, the two alloy-steel rolls are supported on horizontal bearings. These rolls are hardened and thread-ground from the solid. Their diameter ranges from 5 7/8 to 6 1/4 inches, depending upon the size of the work-piece. One roll rotates clockwise on a stationary bearing support, while the other, rotating in the same direction but on a movable carriage, is fed toward the stationary roll by hydraulic pressure.

The blank rests in a horizontal position on a supporting blade between the rolls, as shown in Fig. 19, and during the rolling operation, it rotates, but does not move axially. An outboard support is used for holding long work-pieces in a horizontal position.

Means are provided to adjust the rolls quickly, so that they are in exact matching position. The maximum amount of working pressure exerted by the rolls can be varied in accordance with the pitch of the thread, the requirements of the material, and the nature of the work-piece. An automatic sizing control releases the

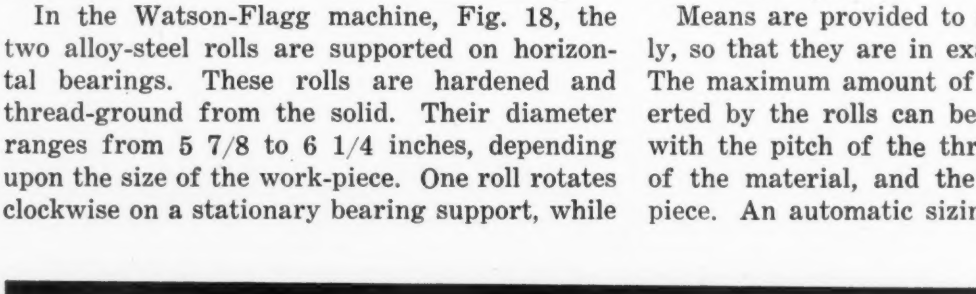


Fig. 19. Essential Details of Watson-Flagg Cylindrical-die Thread-rolling Machine

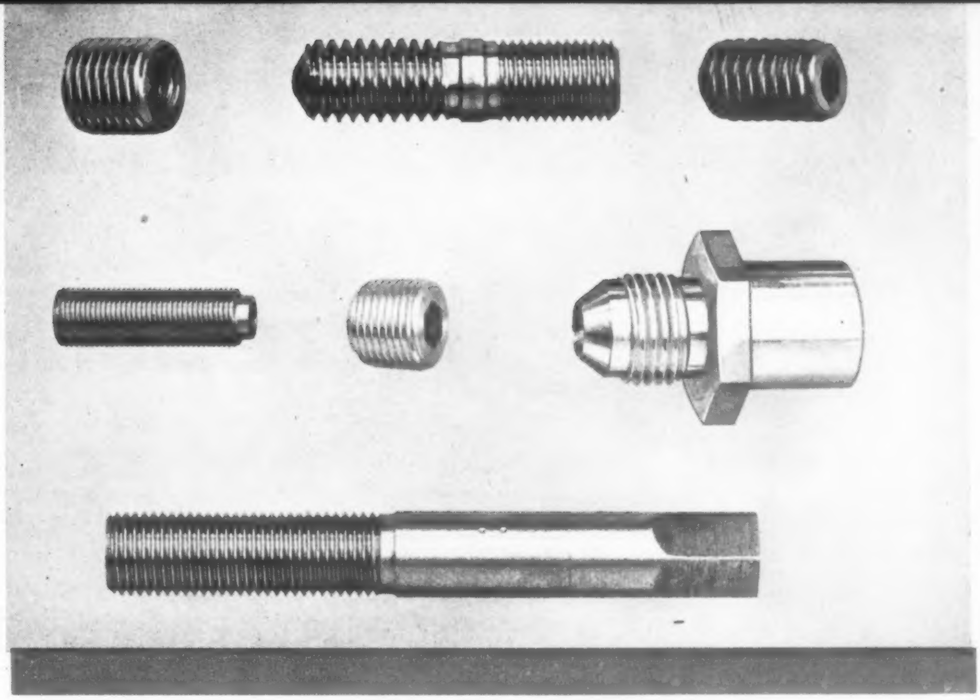


Fig. 20. Examples of Work Turned out on Cylindrical-die Machine. A Controlled Rate of Die Penetration Permits Rolling of Hollow Pieces. Other Typical Work-pieces are Illustrated Below

hydraulic pressure on the roll when the required pitch diameter of the threaded part is obtained, and returns the roll mounted on the movable carriage to its starting position. Slightly tapered threads can be obtained by adjusting the bearing block for the roll that revolves in a stationary position to the required angle.

One of the outstanding advantages of cylindrical dies, as compared with flat dies, is that they provide a continuous and almost unlimited rolling course, so that the rate of penetration into the blank can be made as gradual as the occasion requires. In the case of work-pieces that are hollow, too rapid penetration might tend to collapse the inner wall. By using cylindrical dies, however, threading of pieces of this type is readily accomplished. This can be done with or without a supporting mandrel, depending upon the thickness of the wall and the coarseness of the thread required. Some examples of solid and hollow work-pieces that have been thread-rolled on a cylindrical-die machine are shown in Figs. 20 and 21.

To mention but one case, a hollow blank was rolled with cylindrical dies so that the root of the thread was only 1/32 inch from the inside wall. To prevent buckling of the work-piece, the rate of penetration had to be relatively slow. If flat dies had been used at the same rate of penetration, they would have had to be 14 1/2 feet long. Work-pieces of short length, tapered work-pieces, and those requiring a threaded portion close to a shoulder are also readily handled in the cylindrical-die machines.

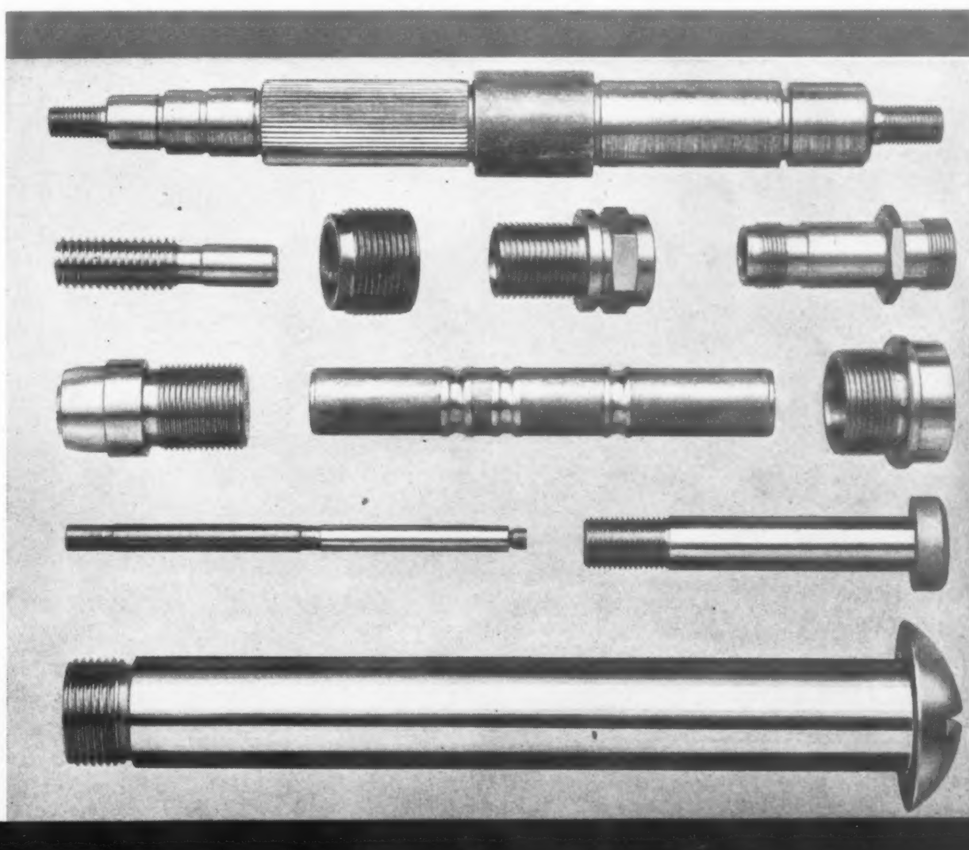


Fig. 21. Solid and Hollow Threaded Parts Thread-rolled on Cylindrical-die Machine

Increasing Life
Steel Tools

A Description of Current Practice in Applying Two Nitriding Processes to High-Speed Steel Tool Case-hardening—the Holden Hy-Speed Case Treatment Outlined by General Committee on Metallurgy of General Electric Co., and the "Maxi" Process Developed by Greenfield Tap & Die Corporation

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# of High-Speed by Nitriding

DURING the last year, great difficulty has been encountered in obtaining high-speed tool steels in sufficient quantity. The War Production Program has severely taxed the capacity of the steel mills to produce the material and of tool manufacturers to fabricate and treat the tools. Under such conditions, the life of the tool per grind becomes increasingly important, and any treatment that will give existing tools greater life is of prime importance. It has been found that, in many cases, the application of a nitriding treatment for high-speed steel cutting tools will result in materially increasing the life of these tools. Such a nitriding process, known as the Holden Hy-Speed Case treatment, has been developed by the A. F. Holden Co., New Haven, Conn.

This treatment consists primarily of nitriding the surface of the tool after it has been hardened, tempered, and finish-ground. The Holden Hy-Speed Case salt consists of a eutectic mixture of sodium and potassium cyanides which begins to melt at 850 degrees F., becomes completely liquid at 950 degrees F., and is usually applied to the tools at 1025 to 1050 degrees F. The salt is water-soluble, and can be washed from the tools after treatment. It is relatively stable, and can be used indefinitely without substantial change in characteristics, provided approximately 5 per cent of new salt (depending on usage) is added each week. In the case of pots in constant use, this deterioration is more than taken care of by replacing the "dragout."

Pots and Furnaces Used for Salt Bath

A steel pot is recommended for this material. The relatively low operating temperature results in long pot life—much longer than with the usual carburizing salt bath, which operates at a much higher temperature. The pot can be heated by either gas, oil, or electricity. It is desirable to provide automatic controls, in view of the necessity for maintaining a uniform temperature. Any substantial variations in bath temperature may result in variations in hardness and case depth, and seriously impair the life of the tools.

The melting pot, thermo-couple protection tube, and basket used should contain no nickel, as it has been found that if a nickel-alloy pot is used, there is some tendency for the nickel to become plated on the tools, thereby retarding the nitriding process, and causing the case to be more brittle. The use of pressed-steel pots, chromium-iron thermo-couple protection tubes, and iron wire baskets is recommended.

Prerequisites for Successful Application of Process

The first requirement is that the high-speed steel tools should be properly hardened, tempered, and ground before applying the Holden treatment. If the tool has not been sufficiently hardened, it will be either too soft for the application of the treatment or it is likely to lose much of its remaining hardness during the treatment.

For example, if the tool after hardening, tempering, and grinding has a hardness of from 60 to 61 Rockwell C, indicating that it has been underhardened or overdrawn, the likelihood is that during the subsequent treatment at from 1025 to 1050 degrees F., it will lose another point or two in hardness. At best, the hardness reading will be from 59 to 60 Rockwell C. This tool may still cut soft non-ferrous materials advantageously; but in cutting steels, even in the annealed condition, a high-speed steel tool as soft as this may not work well.

It is also important to bear in mind that if the high-speed steel tools are not ground after hardening and tempering, but are immediately

subjected to the Hy-Speed Case treatment, there must be no appreciable thickness of soft skin on the cutting surfaces of the tools, because, while the treatment will compensate for a soft skin condition if it does not exceed 0.0005 inch, it will not entirely correct the condition if the soft skin is from 0.001 to 0.002 inch thick.

Now, assuming that the high-speed steel tool is properly hardened, tempered, and ground, we are ready to apply the special nitriding bath. In melting the salt that forms the bath, the heat should be applied gently, so as not to overheat the pot and unduly oxidize and scale it.

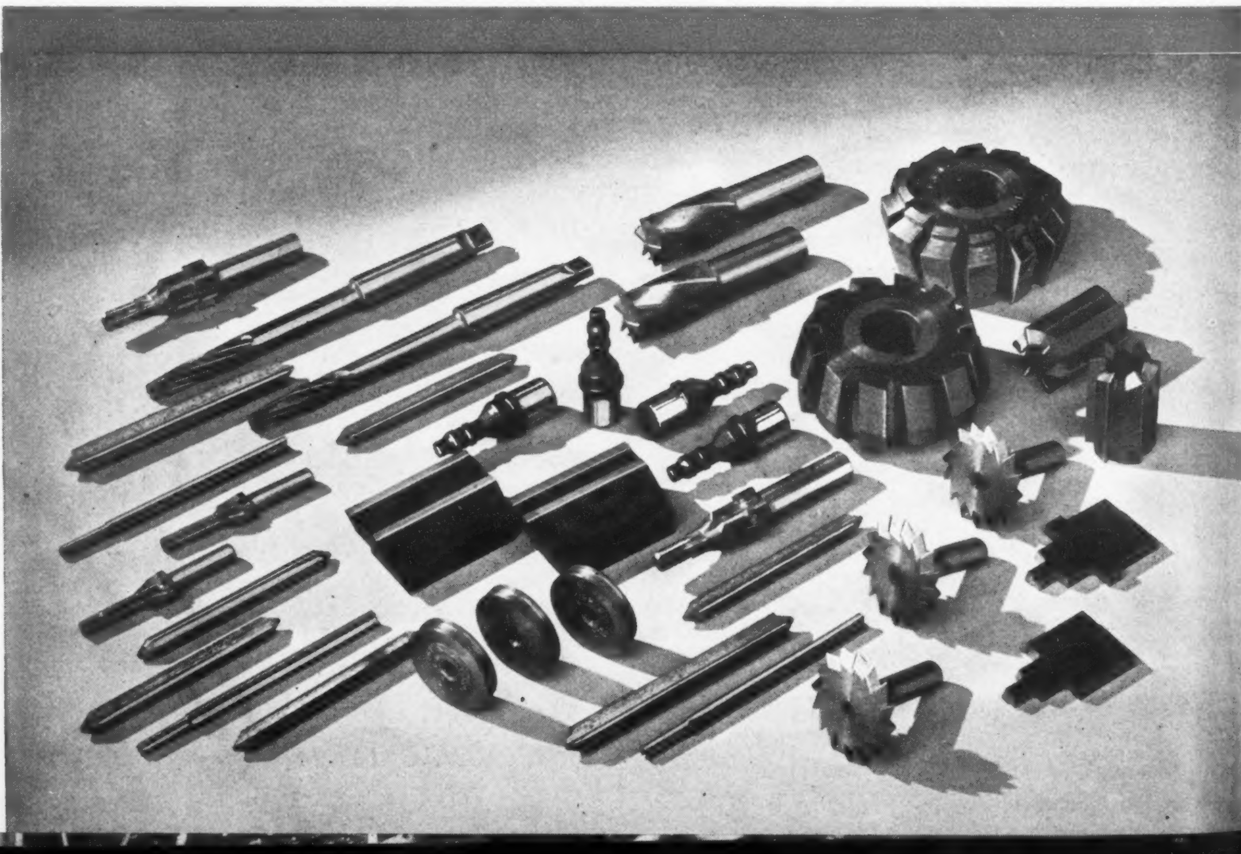
After the bath has melted, the temperature should be set at from 1025 to 1050 degrees F. and "aged" for twelve hours before being applied to the high-speed steel tools. At the conclusion of the aging period, the tools, properly degreased and cleaned, are preheated to from 700 to 750 degrees F. They are then introduced into the bath and held for a period of from two to sixty minutes, depending upon their size, shape, and intended use. The time for the average tool is most commonly from twenty to thirty minutes. When the tools are quite small, from ten to twenty minutes is sufficient, but when they are very large, from thirty and even up to ninety minutes may be required.

The length of time of immersion also depends upon whether the tools are to be used for ferrous or non-ferrous metals. A shorter heating time is advisable for tools used on iron and steel, whereas when used on non-ferrous metals, a considerably longer time may be necessary.

Length of Time of Heating in Bath for Different Types of Tools

The following specific examples relating to time of holding the tools in the bath will be of aid to the user of this process: Straddle-milling cutters and circular form tools 1/4 inch thick would be immersed from 20 to 30 minutes; 1/2 inch thick, from 30 to 45 minutes; and 1 inch thick or more, from 45 to 60 minutes. Drills, reamers, and end-mills 1/4 inch in diameter, 10 to 20 minutes; 1/2 inch in diameter, 20 to 30 minutes; 3/4 inch in diameter, 30 to 45 minutes; and 1 inch in diameter, 45 to 60 minutes. Taps 1/4 inch in diameter, 6 to 8 minutes; 1/2 inch in diameter, 8 to 12 minutes; 3/4 inch in diameter, 10 to 15 minutes; and 1 inch in diameter, 20 to 25 minutes. Hobs weighing 1/2 pound, from 15 to 20 minutes; 1 pound, from 20 to 30 minutes; 2 pounds, from 30 to 40 minutes; and over 2 pounds, from 45 to 60 minutes. Slotting saws 1/4 inch in diameter, from 6 to 8 minutes; 1/2 inch in diameter, from 8 to 10 minutes; 3/4 inch in diameter, from 8 to 12 minutes; and 1 inch in diameter, from 10 to 12 minutes.

Fig. 1. High-speed Steel Tools of Various Types that have been Nitrided by Holden Hy-Speed Case Treatment



After the heat-treatment, the tools are removed from the bath and are allowed to cool in the air. When cold enough to handle, they are washed and cleaned in boiling water.

This treatment has been found to impart an extremely hard and wear-resistant surface to the tools. The depth of the case varies from 0.0002 to 0.0005 inch, the surface hardness being from 70 to 75 Rockwell C. With this hardness, there is inevitably increased brittleness of the cutting edge. In order to reduce this brittleness and toughen the cutting edge, it is recommended that after the Hy-Speed Case treatment, the tools be drawn in a tempering bath held at about the same temperature as that used for the nitriding bath. This final draw covers the steel with a film of oxide, and at the same time reduces the tendency to brittleness. The film of oxide appears to act as a lubricant, and thereby further increases the life of the tool.

After the final draw, the tools are again allowed to cool in the air and are then washed in hot water and dipped in hot oil. This oil-dipping process produces an attractive black finish on the tools, which are now ready for use.

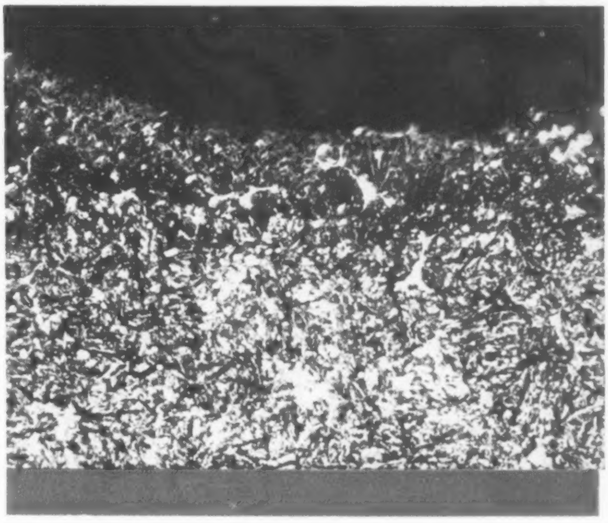


Fig. 2. Photomicrograph (500X Magnification) of a High-speed Steel Cutter Nitrided by Holden Hy-Speed Case Treatment which Shows the Depth of Case after One Hour of Treatment. The Estimated Depth was 0.0015 Inch. Etching Solution Comprised 2 Per Cent Nital

Results Obtained from Nitriding Treatment

At the General Electric plants, the treatment has increased tool life from 10 to 600 per cent, but in most cases, an increase of from 50 to 150 per cent is recorded. In some of the tests, the treatments were varied, in order to determine the proper time of immersion in the bath. Tests indicate that there is an optimum treating time for each type of tool, and this must be determined by experimentation. Long treatments increase the depth of case and consequent brittleness, and conversely, short treatments result in a shallow case of low nitrogen concentration. Care must be taken to avoid breakage of tools by using only the depth of case required for the application in hand. It has been noted that experienced operators are getting better results than new operators. This may be taken as an indication of the effect of the increased brittleness due to nitriding.

A few examples of the results obtained in other plants by such treatment of high-speed steel tools may be mentioned. An untreated step-reamer for finishing a bore averaged 210 holes before it needed grinding; after having been treated as outlined, such reamers averaged from 780 to 850 pieces before grinding.

A 3/4-inch bottoming tap with 18 threads to the inch averaged, untreated, about 100 holes; treated taps averaged from 650 to 700 holes. A forming tool averaged 150 pieces without treatment; when treated, it produced 450 holes before sharpening; after the first sharpening, it produced another 250 holes; and after the second sharpening, 170 holes. By this time, obviously, the case was fairly well ground off. Similar examples could be multiplied indefinitely.

All kinds of high-speed steels—regular 18-4-1, molybdenum, or cobalt types, or any combination of tungsten or molybdenum—and steels of the high-carbon high-chromium type, can be treated advantageously in this nitriding bath. The latter type of steel should be treated at a somewhat lower temperature than the regular high-speed steel, say from 950 to 1000 degrees F.

Examples of the Application of the Process at Various General Electric Works

In the following paragraphs, additional information is given as to specific methods used and results obtained at a number of General Electric plants. The Lynn River Works specifies 1050 degrees F. for the heat of the bath for practically all tools being treated. However, for very small or fragile tools, temperatures as low as from 950 to 1000 degrees F. may be used. In general, it has been found that a case 0.0005 inch thick is formed in 15 minutes, and that an additional thickness of 0.0005 inch is formed in

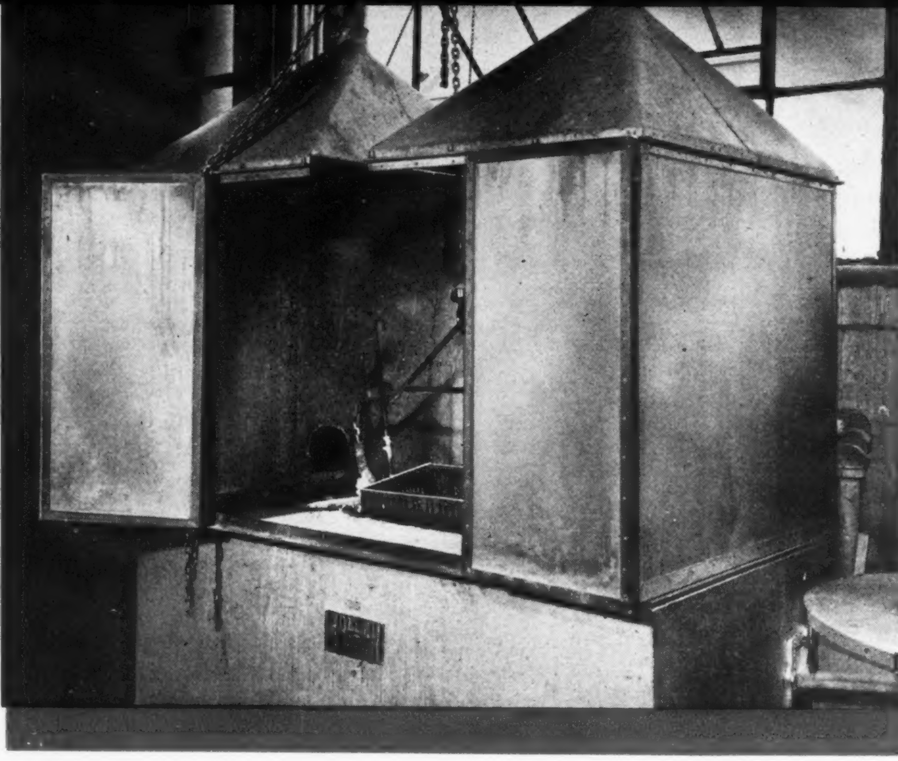


Fig. 3. *A Gas-fired Recuperating Furnace Used in Performing Nitriding Operations on High-speed Steel Tools*

each 15-minute interval until a case 0.0015 inch thick is obtained.

In addition to increasing the life of the tools, the treatment has resulted in tools that produce a better finish on the work and that have considerably less "pick-up." Drills, especially, seem to cut much cleaner, and the benefit from one treatment remains after numerous regrindings.

Tools that are ground on the contour or profile must be treated after each grinding, whereas tools that are ground on the face continue to give good results after repeated grindings.

At the Pittsfield Works, it was observed that while tool life was increased to a marked degree by nitriding, failure by breakage in the case of small and slender tools was frequent, both in the untreated condition and after the nitriding treatment. To overcome this difficulty in the case of nitriding tools, it was found to be advantageous to draw the temper of these tools after the nitriding treatment to a somewhat lower hardness than would have been used for untreated tools. In this way, the tool breakage was greatly decreased.

An example of such an improvement was noted in No. 8-32 taps, which, before treatment, had an average life of only 13 operations. This figure was increased to 38 operations after the treatment, and to 62 operations after the taps had been drawn to a hardness of 58 Rockwell C.

The methods used at the Fort Wayne Works are the same as previously described in this article. Temperatures of 950 to 1050 degrees F. are used in treating tools for such materials as copper or copper alloys, silicon sheet steel, fiber, and Bakelite. If the initial hardness of the tool is high (approximately from 64 to 66 Rockwell C), a bath temperature of from 1050 to 1080 degrees F. is used, as otherwise the tools have been found to be likely to chip.

The bath is checked daily for sodium cyanide content, which is maintained at or above 12 per cent. Any sludge which forms in the bottom of the pot is removed.

It has been found at the Fort Wayne Works that, when working with the higher molybdenum steels, better tool life is obtained if the temperature of the treating bath is from 45 to 55 degrees F. higher than that used for high-tungsten steels. The number of pieces produced by the tools has been trebled in a great many instances, and in a few cases as much as twelve times the production has been obtained, especially from taps and drills.

At the Bridgeport plant, the bath used consists of either a mixture of approximately 65 per cent sodium cyanide and 35 per cent potassium cyanide or a commercial mixture available on the market. Before nitriding, all cutting tools are carefully sharpened to obtain the best possible cutting edge. Care is also taken to remove the decarburized portion of the cutting edge; this is particularly important if the tools have not been hardened in a controlled-atmosphere furnace or salt bath. Tempering is, like nitriding, preceded by a preheat of 350 degrees F. Generally speaking, the hardness of the case is about half way between that of high-speed steel, untreated, and carbide tools.

The nitriding treatment in this plant has been applied to tools made from practically every standard type high-speed steel—18-4-1, 18-4-2,

6-6-4-1, 6-6-4-2 — and several of the cobalt types. The nitrided 6-6-4-1 type of steel has been found especially suitable for plug gages. With a double draw after hardening, these can be ground within 0.0002 inch of the final size before nitriding, allowing only a little over 0.0002 inch for lapping.

Nitriding Tools by the "Maxi" Process

The so-called "Maxi" treatment developed by the Greenfield Tap & Die Corporation for application to all types of high-speed steel cutting tools is a liquid bath nitriding treatment similar to that obtained by commercial liquid salt baths, such as Holden's Hy-Speed Case and Houghton's Liquid Heat No. 720. The "Maxi" bath, however, is made up by the Greenfield Tap & Die Corporation's plants for their own use under the supervision of the corporation's research department. Methods of process control to insure uniformity of results have also been carefully developed.

A new bath is started by using a mixture of sodium and potassium cyanides, properly aged. In this bath, the total cyanogen and the total cyanate contents are thoroughly controlled, while the carbonate content is kept at the required percentage by lowering the temperature of the bath about once a week to 850 degrees F., when the excess carbonate settles out and is later removed by means of a perforated spoon or ladle. Pressed-steel or straight-chromium cast-alloy pots with a nickel content less than 0.5 per cent are essential to prevent plating of nickel on the tools being treated.

The operating temperature of the bath varies from 1000 to 1050 degrees F. No essential difference in the results obtained when operating between these temperatures has been found. The higher temperature, however, is preferred. For certain types of tools, there appears to be an advantage in the use of a second salt bath treatment at the same temperature as that of the first bath, or slightly higher. All "Maxi" treated tools are blackened for identification.

The following examples of results obtained in the commercial application of "Maxi" treated tools will indicate how this nitriding process improves the cutting qualities and life of tools.

A Bridgeport, Conn., concern does a great deal of tapping in cast iron with machine screw taps. Ordinarily, the best production obtainable before regrinding taps is 250 holes. Taps subjected to nitriding treatment average 500 holes per tap per grind. In another plant, drills so treated have an increased life between grindings of as much as three and one-half times.

Some very unusual results were obtained by a San Francisco screw products company in tapping cast-iron holes 2 1/2 inches long with 1/2-inch taps having 13 threads per inch. Here the performance was increased from 86 holes per tap to 804 holes, with two regrindings.

Anchor Shank Forging being Cut to Required Length at the Baldt Anchor, Chain & Forge Co., by a Marvel High-speed Ball-bearing Saw. The Section of the Forging being Cut Measured 10 by 4 1/2 Inches

Milling Aluminum up to 19,000

Everyday Practice in a Plant of the Lockheed Aircraft Corporation on Milling Machines Equipped with Spindles Driven by High-Cycle Motors

By J. S. HALDEMAN
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Factory A, Lockheed Aircraft Corporation
Burbank, Calif.

THE success of aircraft companies in milling extruded aluminum-alloy spars at cutting speeds much higher even than those employed in woodworking prompted engineers in the former Vega plant (now Factory A) of the Lockheed Aircraft Corporation, Burbank, Calif., to adapt standard milling machines for operations at similar speeds on small aluminum forgings and castings, as well as extruded shapes. Spindle speeds up to 13,000 R.P.M. have been used on these machines, though in the majority of operations the spindle speed is not over 9500 R.P.M. The surface or peripheral speed of cutters ranges up to 19,000 feet per minute, and on many jobs the machine table is fed at the rapid traverse rate of 225 inches a minute. Cutters tipped with tungsten carbide are employed in these operations.

This high-speed milling is performed on standard Sundstrand No. 1 hydraulically fed Rigidmils in which the regular spindles have been replaced by special spindles driven directly by high-cycle synchronous motors. In these drives, the spindle itself comprises the motor armature. It runs in four precision ball bearings, two at the front and two at the rear. This entire spindle unit is accurately balanced to avoid vibration at the high speeds used. The motors were supplied by the Sawyer Electrical Mfg. Co., Los Angeles, Calif. There are six Rigidmils equipped in this manner, four of the machines being of the standard horizontal design, and the other two of the vertical-spindle type.

On the mezzanine above the area in which these milling machines are installed are six electric generators, one for each of the motors that drive the machine spindles. To change the motor speeds, the corresponding generators are simply speeded up or slowed down, as the generator and motor speeds are identical. The motors are all of 20 H.P. rating at 9500 R.P.M., and are of a water-cooled design. An oil vapor is forced to the bearings under a pressure of 100 pounds per square inch to insure satisfactory lubrication. Because of the high spindle speeds at which the machines are operated it is necessary to replace the ball bearings about every six months.

The climb-cut principle is followed in most cases in these "high-cycle" milling operations. This is possible because the hydraulic drive is preloaded to eliminate backlash in the hydraulically fed table. The cutters are generally made with positive rake and helix angles, although in some cases the rake angle is zero or neutral and the helix angle is negative. In the case of slitting saws, the rake angle is positive, but the teeth run straight across the body without any helix angle. For milling flat stock, such as strip metal, the cutter teeth are sometimes set at a slight negative helix angle, as this provision tends to force the work-piece down flat on the fixture and absorb any end play in the spindle.

Cutters for high-cycle milling are made with fewer teeth than the negative-rake cutters employed for milling steel. It is recommended that the "chip load," or feed per tooth, be not less than 0.003 inch; it may be as high as 0.020 inch if the machine has sufficient driving horsepower. All these cutters are of the solid type, with tungsten-carbide tips brazed right on the cutter bodies. All cutters for high-cycle milling are

at Cutting Speeds
Feet a Minute!

An Operation in which an 8-inch Cutter was Run at a Peripheral Speed of 18,900 Surface Feet per Minute with a Table Feed of 225 Inches a Minute

MILLING

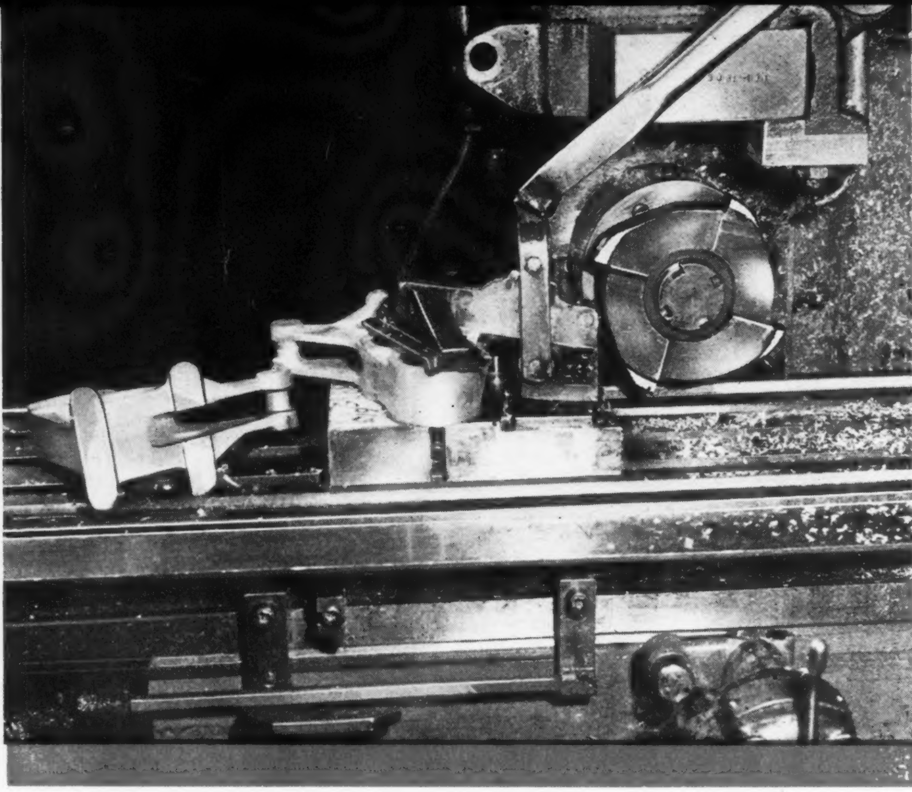


Fig. 1. Milling Aluminum Sand Castings at a Cutter Speed of 7850 Surface Feet per Minute, with a Table Feed of 50 Inches per Minute

painted red on the sides to distinguish them readily from negative-rake steel milling cutters which are not painted.

Typical production operations on these high-cycle machines will now be described. Fig. 1 shows an operation in which three pads of toe brake brackets are being milled. These parts are aluminum-alloy sand castings. The total area milled is approximately 5 square inches, and stock is cut to a maximum depth of 1/8 inch. The 6-inch cutter has four blades. It is run at 5000 R.P.M., or 7850 surface feet per minute, and the table is fed 150 inches a minute.

Particular attention is called to the quick-acting clamp on the work-fixture. It is desirable to provide means for quickly loading the fixtures of these high-cycle milling machines, as otherwise the loading time may greatly exceed the machining time. The cutting time in this operation is 87 seconds. No cutting coolant is used.

When the photographs shown in the heading illustration and Fig. 1 were taken, guards were removed from the milling machine to give an unobstructed view of the milling cutter. The same is true of all other illustrations presented in this article.

In Fig. 2 is shown a vertical-spindle machine engaged in milling shims of 24 ST Duralumin

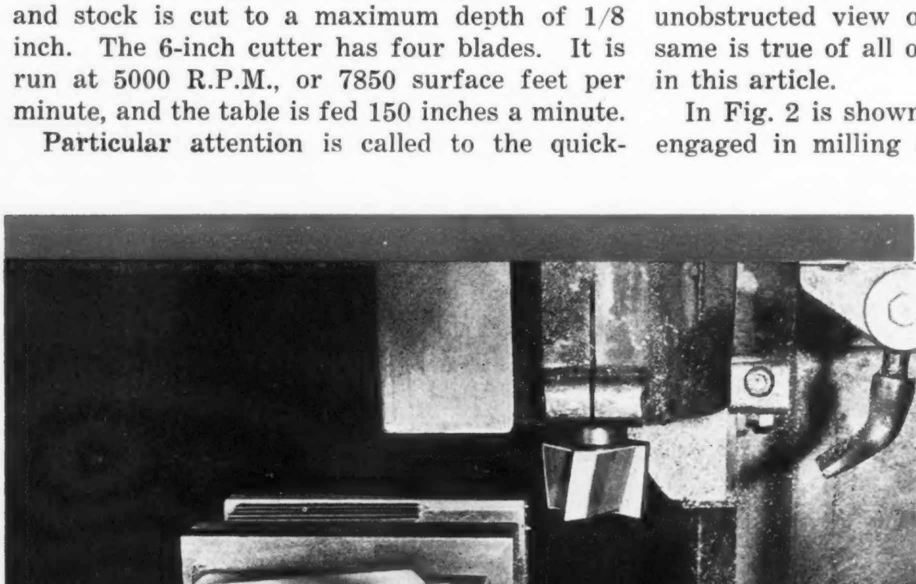


Fig. 2. Milling Shims of 24 ST Duralumin at a Cutter Speed of 5500 Surface Feet per Minute, with a Table Feed of 225 Inches a Minute

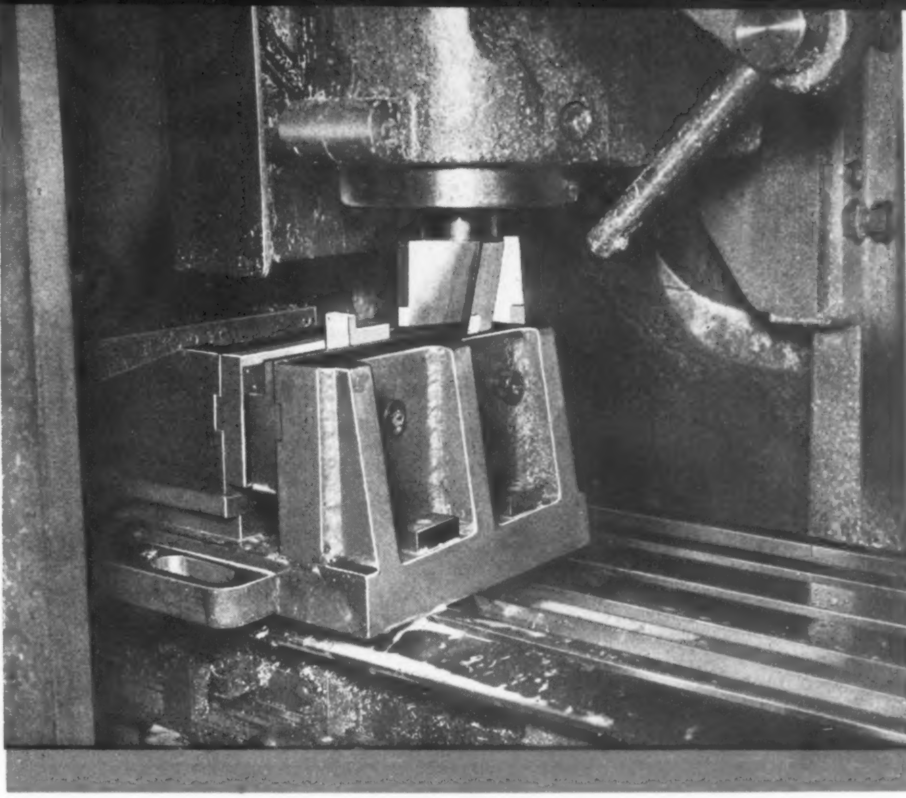


Fig. 3. Spindle is Run at 8500 R.P.M. and Table Fed 100 Inches a Minute in Taking a Cut 1/4 Inch Deep on 24 ST Aluminum

at an angle of 12 degrees on the edges. About a dozen shims are clamped in the vise for simultaneous milling. The 3-inch diameter cutter is run at 7000 R.P.M., or approximately 5500 surface feet per minute, and the table is fed at the rapid traverse rate of 225 inches a minute. Stock is removed to a maximum depth of 1/32 inch. The actual cutting time is 6 seconds, and the floor-to-floor time 18 seconds for twelve parts. The four cutter teeth are ground to a positive rake and a positive helix angle of 7 degrees. No cutting coolant is used.

Another operation on a vertical-spindle machine in which a cut is taken to a depth of 0.270 inch is shown in Fig. 3. The work is a piece of 24 ST aluminum alloy, and is being face-milled with a 2 1/2-inch diameter cutter having four teeth. These teeth have a positive rake of 10 degrees and a positive helix angle of 10 degrees. The spindle is run at 8500 R.P.M., which corresponds with a peripheral speed of 5570 surface feet per minute. The table is fed at the rate of 100 inches a minute, giving a feed per tooth of 0.003 inch. The jaws of the work-fixture on this machine are operated by air. The floor-to-floor time for this operation is only 10 seconds per part. The cutter blades are HA Firthite. Soluble oil is used as a coolant.

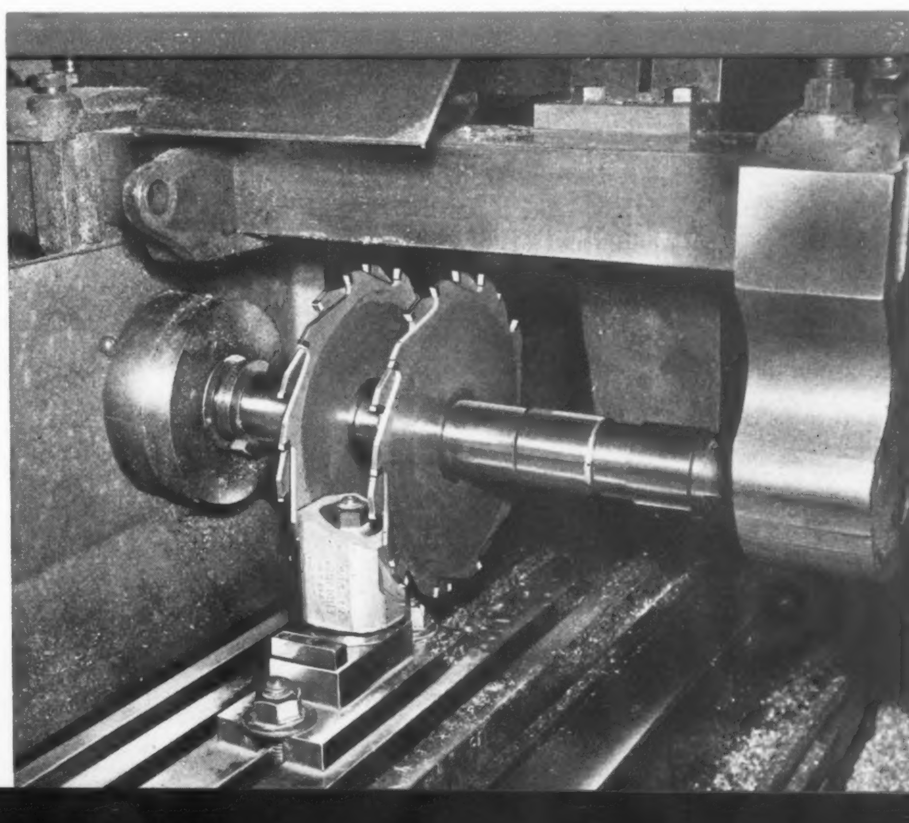


Fig. 4. Operation on Sand Castings in which the Production has been Speeded up 500 Per Cent by the Application of High-cycle Milling

MILLING ALUMINUM AT HI

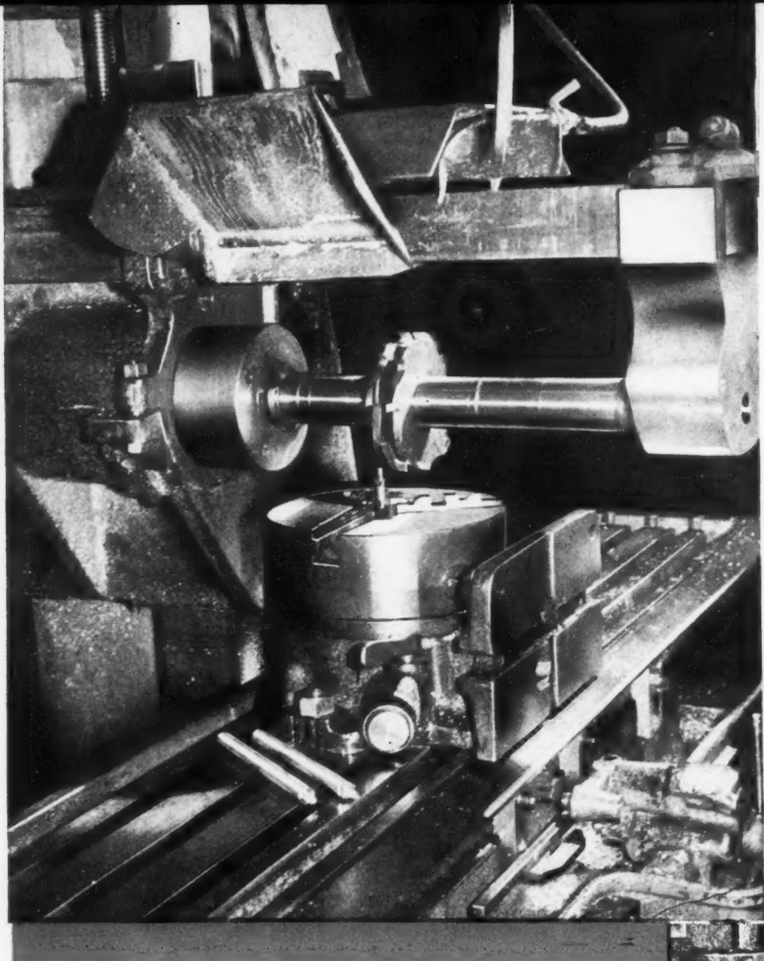


Fig. 5. (Left) Straddle-milling Operation in which Squares are Cut on Round Rod with the Table Fed at the Rate of 225 Inches a Minute

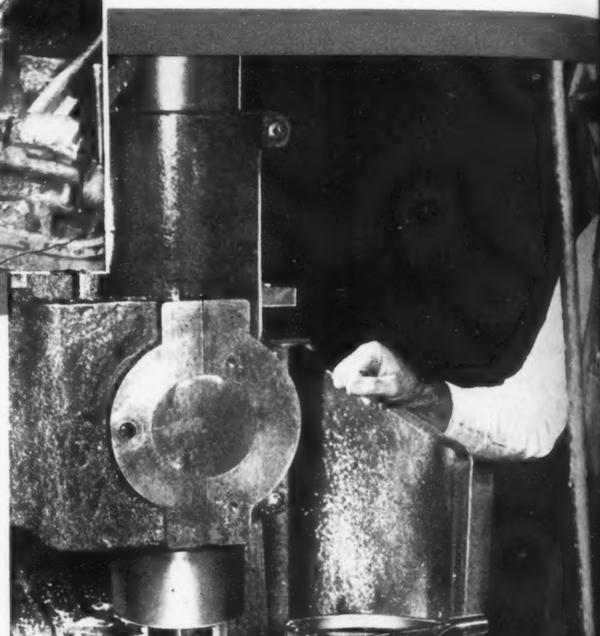


Fig. 6. The Small Shell End-mill Shown in Use is Made with Tungsten-carbide Blades Set to a Negative Helix Angle of 15 Degrees, which Aids in Holding the Thin Strip Metal down on the Fixture

A straddle-milling operation in which a square section is milled for a height of 3/16 inch on 1/2-inch diameter pins of 24 ST Duralumin is illustrated in Fig. 5. The milled section must be 0.375 inch square within plus or minus 0.0015 inch. Two sides of the square are milled at one pass of the work, after which the chuck that holds the pins is indexed 90 degrees for milling the other two sides. The cast Meehanite cutter bodies are 5 inches in diameter, and have eight teeth with positive rake and helix angles of 10 degrees. The table feed in this operation is 225 inches a minute.

Gussets of 24 ST Duralumin are being scarfed on the vertical-spindle machine shown in Fig. 6. The tapered cut varies from 0 to 0.081 inch in depth, and is taken for a width of 2 1/2 inches. The 2 3/4-inch diameter cutter is run at 9000 R.P.M., which corresponds with a speed of 7240 surface feet per minute. The table feed is 225 inches a minute, or 0.012 inch per cutter tooth. The actual cutting time for this operation is 6 seconds, and the floor-to-floor time 25 seconds, which represents a large increase over the production previously obtained by conventional milling. There are only two tungsten-carbide blades on the cutter. They are Firthite HA, and are set to a positive rake angle of 10 degrees and a negative helix angle of 15 degrees.

The high-cycle straddle-milling operation seen

HIGH SPEEDS

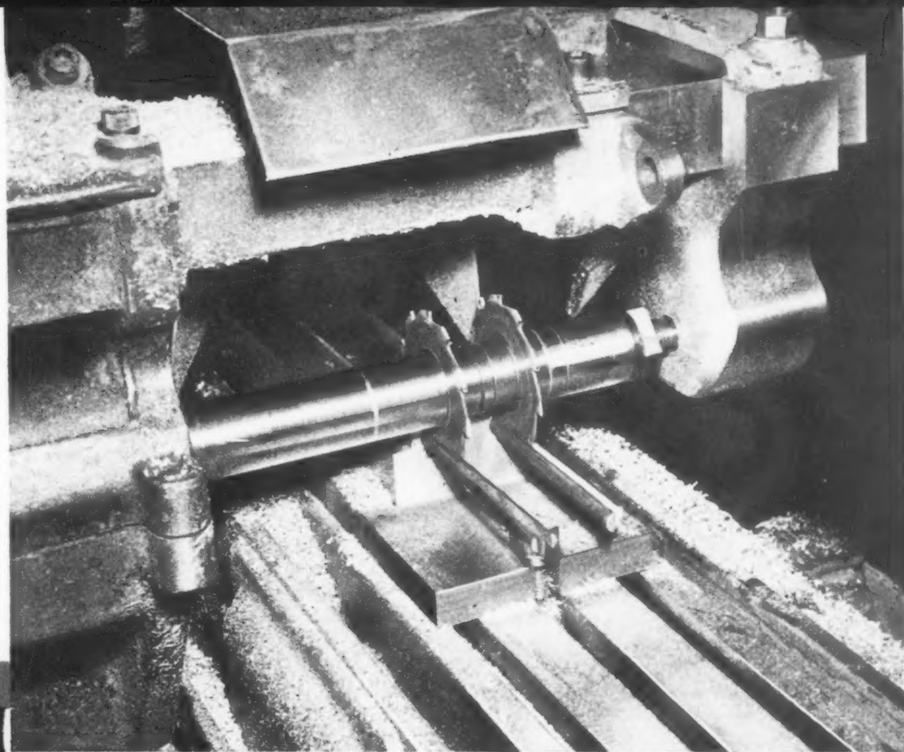


Fig. 7. (Right) Slitting Operation Performed at a Spindle Speed of 9000 R.P.M., the Two Rods being Fed through the Fixture by Hand

Fig. 8. Slab Milling Cutter being Employed for an Operation on Thin Strips of Asbestos. The Cutter is Run at 9000 R.P.M., and the Table Feed is 225 Inches a Minute

in Fig. 4 being performed on a sand casting has resulted in a production increase of 500 per cent over the output formerly obtained by conventional milling with high-speed steel cutters. In this operation, two cutters are placed together to absorb side thrust. They cut to a depth of 1/8 inch. The cutters are 8 inches in diameter and are run at 7000 R.P.M., or approximately 14,700 surface feet per minute. The table feed is 110 inches per minute, which corresponds to a feed of 0.0015 inch per tooth. This is below the minimum mentioned as being required for satisfactory cutter life; however, there was not enough horsepower for cutting with the desired "chip load." The teeth have a positive rake of 10 degrees, and do not have a helix angle. These carbide tips are also Firthite HA.

Long rods of 24 ST aluminum alloy are cut in two at a feed of about 10 feet per minute in the operation illustrated in Fig. 7, the rods being fed through the fixture by hand while the machine table remains stationary. The spindle runs at 9000 R.P.M., which gives the 4-inch cutters a cutting speed of approximately 9400 surface feet per minute. This corresponds to a feed per tooth of about 0.002 inch. The cutters have ten teeth with a positive rake of 10 degrees and no helix angle. The cutter teeth are Carboloy 44-A. This operation is performed according to conventional milling practice rather than by the climb-cut method, because in view of the hand feed, it was necessary to feed the work against the direction of cutter rotation.

The operation shown in the heading illustration was in the nature of a demonstration which

indicated the still unexplored possibilities of high-speed milling. The 8-inch cutter was run at 9000 R.P.M., or at a peripheral speed of approximately 18,900 surface feet per minute, in cutting extruded shapes of 14 ST aluminum alloy. The table was fed 225 inches a minute, which corresponded to a feed of 0.0025 inch per cutter tooth. The saw, which was 8 inches in diameter, had ten teeth of Kennametal K4H. It was 3/16 inch wide, and the teeth had a 10-degree positive rake and no helix angle.

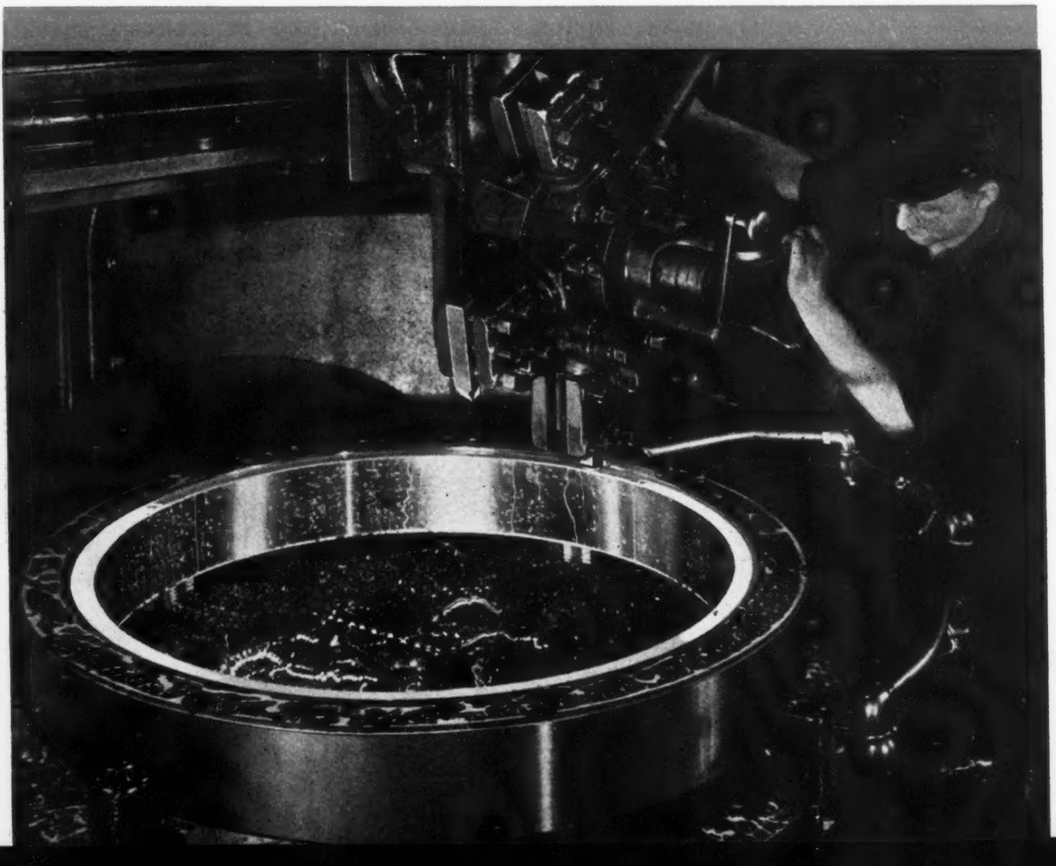
On regular runs on 24 ST aluminum alloy, using a cutter of the same type and the same feeds and speeds, the cutter lasted for fifty hours before showing signs of dulling. An air-operated vise is necessary in this set-up to bring the loading and unloading time into a reasonable relationship with the cutting time. This vise is a Lockheed design and is known as a double-barrel air vise. It measures only 4 inches in height over all.

Thin strips of asbestos are seen in Fig. 8 being milled on one of the high-cycle milling machines. The slab cutter used is 2 1/2 inches in diameter by 6 inches wide, and is run at 9000 R.P.M., giving a peripheral cutting speed of 5900 feet per minute. The table is fed at 225 inches a minute, which gives a feed per cutter tooth of 0.003 inch. The maximum depth of cut is 0.136 inch, the material being taper-milled to a feather edge. The cutter is made of high-speed steel and has helical teeth at an angle of 52 degrees. The operation is performed on the climb-cut principle.

Although the cutting speeds and feeds used in the operations described would have seemed fantastic several years ago, Lockheed engineers do not feel that the utmost possibilities in milling aluminum-alloy forgings and castings have yet been attained. Experience has shown that carbide cutters could be applied at much higher speeds and feeds than those in use if the vibration of cutter-spindles could be eliminated and the machines designed with sufficient rigidity and power.

In most cases, the speeds and feeds used in the operations described were limited by insufficient horsepower at the spindle and insufficient speed of the table. Motors of at least 40 H.P. and table feeds up to 400 inches per minute would be preferable. This would permit increasing the "chip load" per tooth to 0.010 or 0.015 inch, and would double the life of the cutter between grinds.

Large Rolled-steel Rings to be Made into Electric Locomotive Gears are Turned, Faced, and Bored on Bullard Vertical Turret Lathes, as Shown in the Illustration, at the Nuttall Works of the Westinghouse Electric & Mfg. Co.



Turning with Negative-Rake Lathe Tools

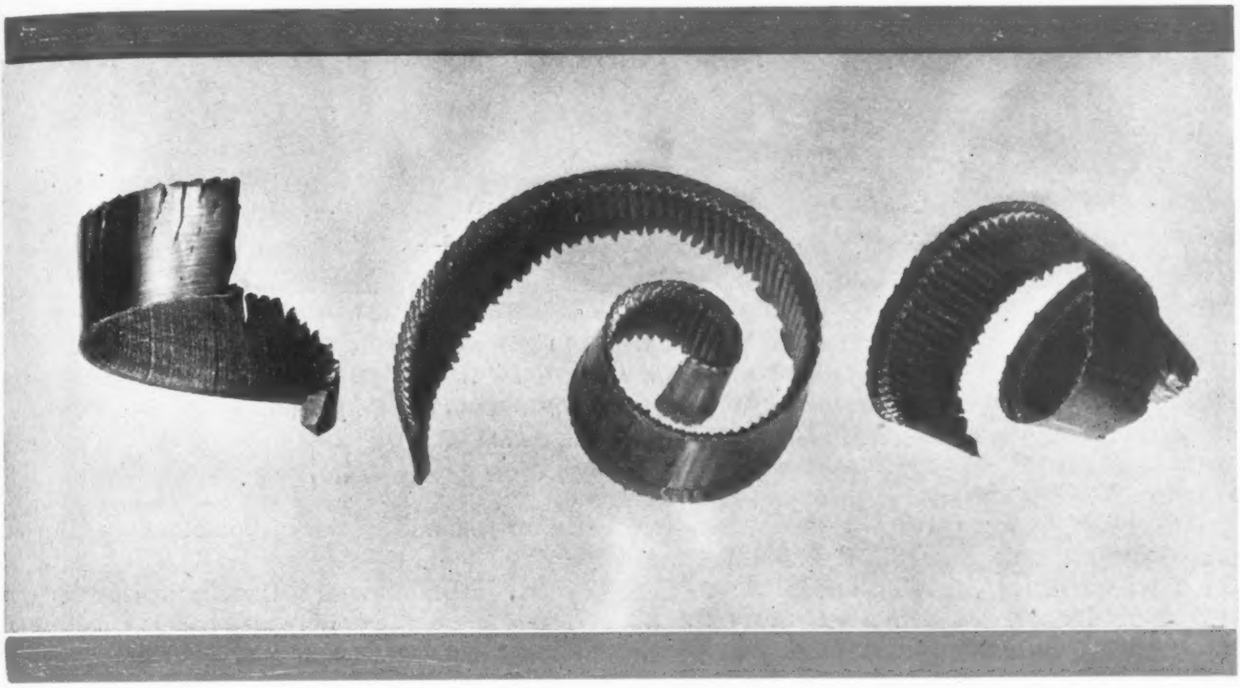


Fig. 1. Chips as Deep as 1 1/16 Inches were Taken with a Feed of 1/32 Inch and a Surface Speed of 125 Feet per Minute by a Turning Tool having a Negative Rake of 4 Degrees

THE fact that very heavy cuts can now be taken on alloy steel with carbide tools will probably be news to many who have long believed that only light cuts, although admittedly at high cutting speeds, could be taken with carbide tools. Recently, Wetter & Williams, New York City, had a contract to rough-turn gun barrels of approximately 3-inch caliber. The forgings for these gun barrels were made from high nickel-chromium steel; they were slightly more than 15 feet long and 9 5/8 inches at the largest diameter.

The barrels weighed 3400 pounds as delivered for rough-turning and 1700 pounds after being rough-turned. Apparently, they had not been straightened after annealing. As a matter of fact, it is doubtful if they had been annealed at all, for they were very hard. They were also very rough, and had an extremely heavy and abrasive coating of scale. In places, this coating was 3/32 inch thick.

The rough-turning operation reduced the barrels about 2 inches in diameter. For rough-turning, tools with shanks made from SAE 1050 steel, carbide-tipped, were first used. The shanks were 1 by 2 by 10 inches, and the tips 3/8 by 5/8 by 1 inch. The tools had a clearance angle of 2 degrees, no top side rake, 4-degree negative rake, 14-degree end cutting edge angle, and 18-degree front clearance angle, as shown in Fig. 3. It was found that the shanks were not stiff enough to successfully take cuts 3/4 inch deep with a feed of 1/32 inch per revolution at 125 surface feet per minute. If a cut only 1/2 inch deep was taken, the entire length of the forging could be turned without regrinding the tool.

Fig. 2. Turning Terminal Shank Forgings at a Speed of 271 Surface Feet per Minute, with an Average Depth of Cut of 3/16 Inch and a Feed of 0.015 Inch by Employing a Lathe Tool with a Negative Rake of 2 Degrees

To obtain better cutting capacity, new tool shanks were made from S A E 1090 steel 2 1/4 by 2 1/2 by 12 inches, as shown in Fig. 3. The tips were also increased to a size of 1/2 by 3/4 by 1 1/4 inches, as indicated, the rake and clearance angles remaining the same. Firthite T-16 was used for the tips, which were brazed into the tool shank by the use of Handy & Harman silver solder.

The lathe on which these gun barrels were turned was a Bridgeford 34-inch size, with a 14-foot bed, which had been extended to accommodate work 17 feet long. This lathe was originally purchased by the Brooklyn Navy Yard in

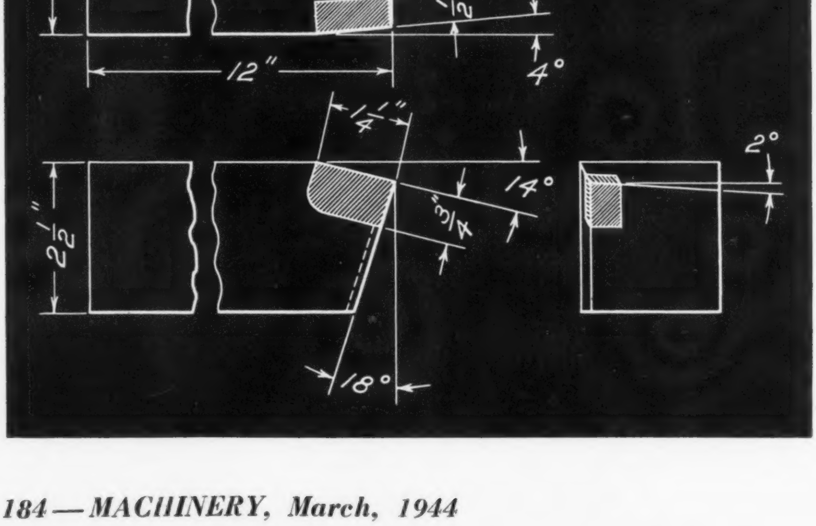


Fig. 3. Drawing that Shows how the Carbide Tool was Ground which Produced the Exceedingly Heavy Chips Shown in Fig. 1

Fig. 4. View of the Turret Lathe Set-up in Fig. 2 with a Finished Terminal Shank Forging Lying on the Carriage. The Four Steps of Different Diameters are Automatically Produced by the Use of a Profile Bar

1918 and had been scrapped as worn out in 1940. Owing to the war emergency and the difficulty of getting new machine tools, Wetter & Williams were able to obtain it for rough-turning. The machine was equipped with a 15-H.P., 800 R.P.M., direct-current motor. This was exchanged for a 30-H.P., 1800 R.P.M., alternating-current motor, equipped with a chain drive which tripled the speed.

With the larger tools, cuts 1 1/16 inches deep were taken with a 1/32-inch feed per revolution and a surface speed of 125 feet per minute. A faster speed could have been used had the lathe been equipped with a heavier motor; but as it was, the motor at times exerted a pull equivalent to 60 H.P. All cutting was done dry, without coolant. The tools cut the entire length of the forgings—about 15 feet—without regrinding. The chips produced are shown in Fig. 1. If a 60-H.P. motor had been employed, a cutting speed of 200 feet per minute could doubtless have been used, with the power input at the point of heaviest pull running up to 120 H.P.

An operation in the machine shop of the Boeing Aircraft Co., Seattle, Wash., in which a carbide cutter ground to a negative rake of 2 degrees is used in a turret lathe for turning terminal shank forgings is illustrated in Figs. 2 and 4. The cutter is ground on the front and side to a clearance angle of 7 degrees. In this operation, the average depth of cut is 3/16 inch, and it is taken at a surface speed of 271 feet per minute, the work being rotated at 460 R.P.M. The feed is 0.015 inch, and the total length of cut 14 inches. Forty-five pieces are turned per grind of the cutter.

A negative-rake cutter is used in this operation because of the square cross-section of the work at one end, which, of course, results in an intermittent cut. For straight cylindrical turning, carbide tools set to a positive rake have stood up satisfactorily. In the particular operation shown, the terminal shank is automatically turned to four different diameters by the use of a profile bar which gives the tool-slide the required in and out movements.

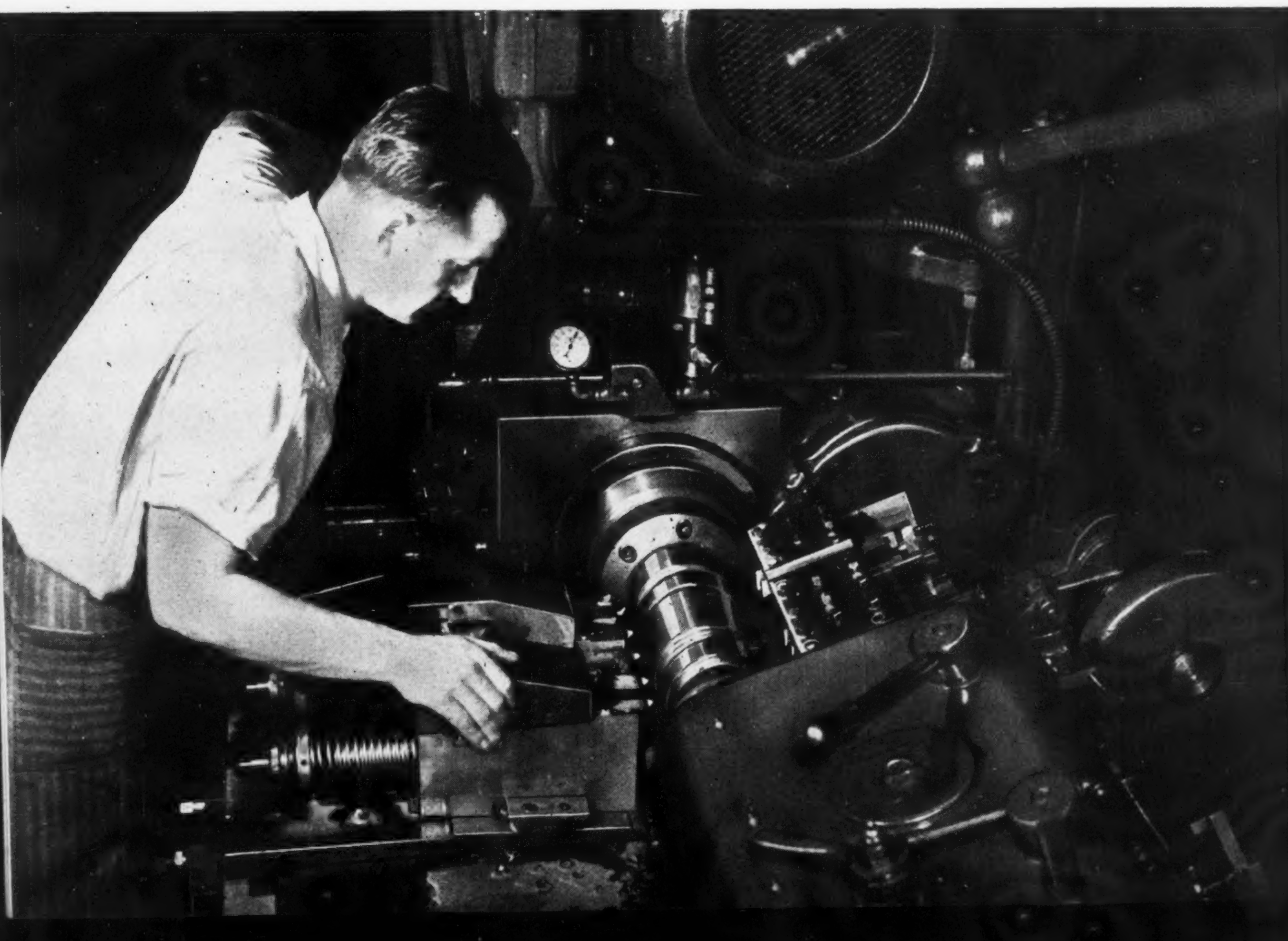
Multiple-Tool with Carbide-

Detailed Information Concerning the Proper Nose Radii, Rake, and Chip-Breaker Width on Tools for Turning Steel

TO meet increased production demands in the manufacture of war equipment, there has been a steady expansion in the use of carbides in multiple-tool set-ups for the turning of steel. On such work it is not uncommon to find machines such as shell turning lathes equipped with motors having a horsepower rating of 50, 75, and even as high as 100 in order to obtain the maximum rate of metal removal.

The results obtained with these amply powered and highly rigid machines will have an important part in influencing the design of future machine tools intended for the multiple-tool turning of steel with carbide-tipped cutters. With such machine and motor capacities, the limiting factor in determining the production rate is frequently the cutting tool, and not the machine itself, as has been the case until recently. For this reason, it is essential that each element involved in tool design and use be given ample consideration in order to assure maximum freedom from tool failure.

The advantages obtainable from the multiple use of carbide-tipped tools have been proved in such operations as that shown in the heading illustration, in which cutters of this kind have increased tool life 1600 per cent in the rough-turning, grooving, and facing of steel sleeves for aircraft-engine cylinders.



Steel Turning Tipped Cutters

By RALPH GRANZOW, Engineer
Carboloy Company, Inc., Detroit, Mich.

Field engineering work in manufacturing plants has disclosed the value of adhering to certain basic principles of cutting tool design. A typical carbide-tipped tool for rough-turning shells, steel shafts, and similar work is shown at *A*, Fig. 2. For light cuts, 1/4 inch deep or less, it is usually better to use a tool having the same general shape as that shown at *A*, but with the tip set straight relative to the shank, as seen at *B*.

The latter tool can easily be produced by regrinding a carbide standard straight tool to the desired shape. The only advantage of tool *A* lies in the fact that it can take heavier cuts because of its greater length of cutting edge. With the same size of carbide tip, however, tool *B* can usually be reground a greater number of times, and is, therefore, preferred for all lighter cuts.

On multiple-tool set-ups it is essential that the nose of the tool be held in a fixed relation to the side of the tool shank. Otherwise the cuts taken by the individual tools may not overlap, or if the cut is of a profile (contour producing) type, the profile will not be accurate. This means that in regrinding, the original shape of the tool must be held. Good practice is to use fairly large angles for the side cutting edge—say around 30 degrees. Most steel turning operations are of such a character that large angles can be used, but if for any reason there is a tendency to deflect the work away from the tools, the side cutting-edge angle can be reduced.

The end cutting-edge angle on turning tools for multiple set-ups is usually 30 degrees, which, in conjunction with the side cutting-edge angle, means that the included angle at the nose is around 90 degrees. This insures adequate strength at the tool nose. The cam on the machine tool that controls the in-feed of the tools at the start of the cut usually possesses an angle of approximately 25 degrees, which means that tools with a 30-degree end cutting-edge angle clear the work at the start of the cut by approximately 5 degrees. For the tool that starts at the end of the work, the end cutting-edge angle can be decreased to 8 or 10 degrees, thus adding to the strength of the tool. However, this is usually not necessary, and it is more convenient and economical to use the same tool design at all positions in a set-up.

Practically all shop men agree that a tool with a large nose radius possesses greater strength and resistance to shock than a tool with a small nose radius or a sharp point. One consideration, however, that is frequently ignored is the fact that the rate of tool wear at the nose is increased when the nose radius is too large in proportion to the depth of cut and feed. This is caused by the chip being thinned out excessively at the nose, as illustrated in Fig. 1.

The optimum nose radius is dependent upon many factors other than depth of cut and feed. Among these are the quality of finish desired, the size and rigidity of the work and the machine, eccentricity or interruptions in the cut, heavy scale on the work, and tool chatter. In spite of the importance of each of these factors, however, the average steel machining job can be performed satisfactorily with tools having nose radii selected according to the accompanying chart. This chart is based on the principle of using larger nose radii for heavier cuts and heavier feeds, which is a well established principle and is in agreement with both metal-cutting theory and actual shop practice.

From the chart it will be noted, as an example, that with a feed of 0.035 inch and a depth of cut of 3/8 inch, the nose radius for interrupted cuts would be 3/32 inch, and for regular cuts 1/16 inch.

In selecting the nose radius for tools used in final finishing cuts on contour profiling work, it

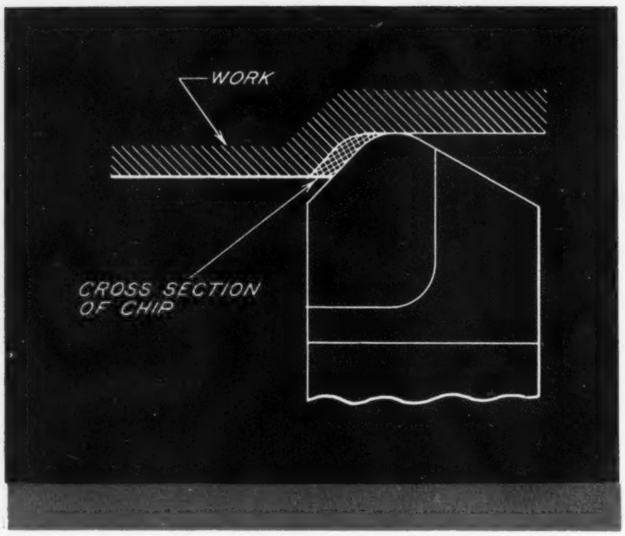


Fig. 1. Diagram which Shows the Cross-section of Steel Chip Produced by a Tool with Too Large a Nose Radius in Proportion to the Depth of Cut and Feed

should be understood that the nose radius must be the same in size as the radius on the cam follower in order to obtain the desired contour on the work. On many machines, the cam follower has a 1/16-inch radius.

Rake angles for multiple set-up steel-turning tools are found to vary somewhat in different manufacturing plants, but in general, tools having a 6- to 8-degree positive side rake and a negative back rake of from 0 to 5 degrees are employed. Rake angles in this range give highly satisfactory tool performance.

In a few instances, the writer has seen tools with no side rake or even a slight negative side rake. The reason this practice was followed was to increase the strength of the cutting edge, but the writer doubts whether the slight increase in strength is enough to compensate for the increased chip pressure and resultant temperature elevation, except perhaps on cuts where heavy scale exists. Since practically all multiple steel-turning tools employ ground-in chip-breakers, it must be kept in mind that the rake angles refer to the bottom surface of the chip-breakers and not to the top face of the tip.

Chip-breakers ground to a depth of approximately 0.020 inch and extending either parallel to the cutting edge or at a slight angle are capable of producing a chip easy to handle without creating undue chip pressure, provided the breaker width is selected to suit the combination of depth of cut and feed. The accompanying table will serve as a guide for proper chip-breaker dimensions.

If for any reason the nose radius on a tool is greater than two-thirds of the chip-breaker width selected from the chart, tool trouble may develop as a result of the choking up of chips in the vicinity of the nose. One method of relieving this condition is to grind the chip-breaker as illustrated in Fig. 3.

A second method is to increase the chip-breaker width. If the width

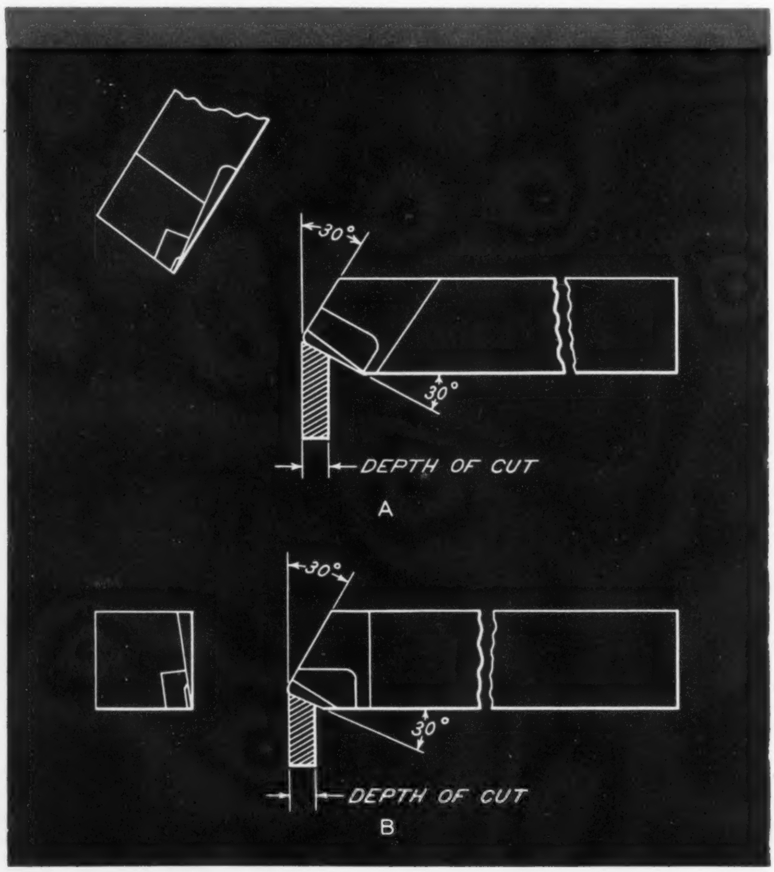


Fig. 2. Diagrams Showing Carbide-tipped Tools for Turning Steel. (A) A Tool Intended for Rough-turning Cuts at Depths Greater than 1/4 Inch; (B) Style of Carbide-tipped Tool Employed for Turning Steel to Depths of 1/4 Inch or Less

is increased, it is usually necessary to increase the depth as well, so as to break the chip properly. Still a third method, which works out well when there is no great variation in depth of cut, is to increase the angle of the chip-breaker. Care should be taken in this case to see that the useful length of the chip-breaker will be sufficient to take care of the heaviest portion of the cut.

In the normal course of tool regrinding, there are two conditions that frequently develop and

Recommended Width of Chip-Breakers

Depth of Cut, Inch	Feed, Inch per Revolution				
	0.008 to 0.012	0.013 to 0.017	0.018 to 0.022	0.023 to 0.027	0.028 to 0.032
	Width of Chip-Breakers, Inch				
1/64 to 3/64	1/16	5/64	3/32	7/64	1/8
1/16 to 1/4	3/32	1/8	5/32	11/64	3/16
5/16 to 1/2	1/8	5/32	3/16	13/64	7/32
9/16 to 3/4	5/32	3/16	7/32	15/64	1/4

Note: A chip-breaker depth of 0.020 inch is satisfactory for most types of steel.

that, if not carefully watched, are likely to create tool trouble. These are the tendency, in regrinding a tool, to enlarge the nose radius beyond the specified dimension and to develop chip-breakers narrower than originally used on the new tool.

Enlarging of the nose radius is due to the fact that the wear land produced in normal operation appears only on the side cutting edge and on the nose, and not on the end cutting edge, since the latter is not in actual contact with the work. To regrind a tool without enlarging the nose radius, the end cutting edge must be reground along with the dull portion.

To insure exact duplication of tool shape, including the nose, templets should be made up for each tool and all tools should be checked against the corresponding templet before they are issued from the grinding room.

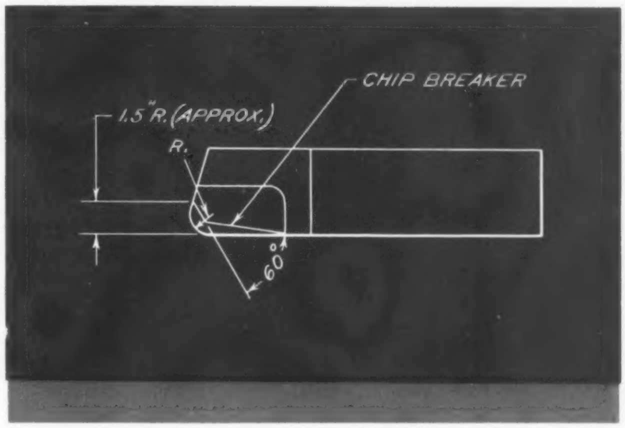


Fig. 3. Type of Chip-breaker which may be Provided where Nose Radius is Larger than Two-thirds the Chip-breaker Width, to Prevent Choking up of Chips

In practice, it is usually found that tools for light cuts can be reground once or twice on the front and side before it becomes necessary to regrind the cutting face (top) of the carbide tip. When this is done more than twice, the chip-breaker width is usually decreased so much that the chips choke up and cause tool trouble. To eliminate any such difficulty, the width of the chip-breaker should be maintained during regrinding to within 0.015 or 0.020 inch of the original width. Tools used for heavy roughing cuts usually require regrinding of the chip-breaker each time the cutting edges are ground.

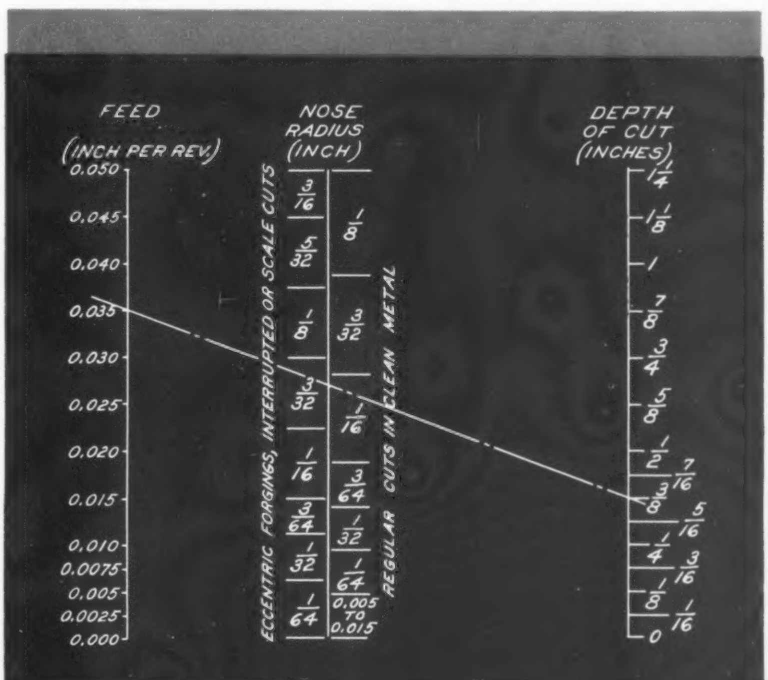


Chart for Determining the Proper Nose Radii on Carbide-tipped Turning, Boring, or Facing Tools for Steel

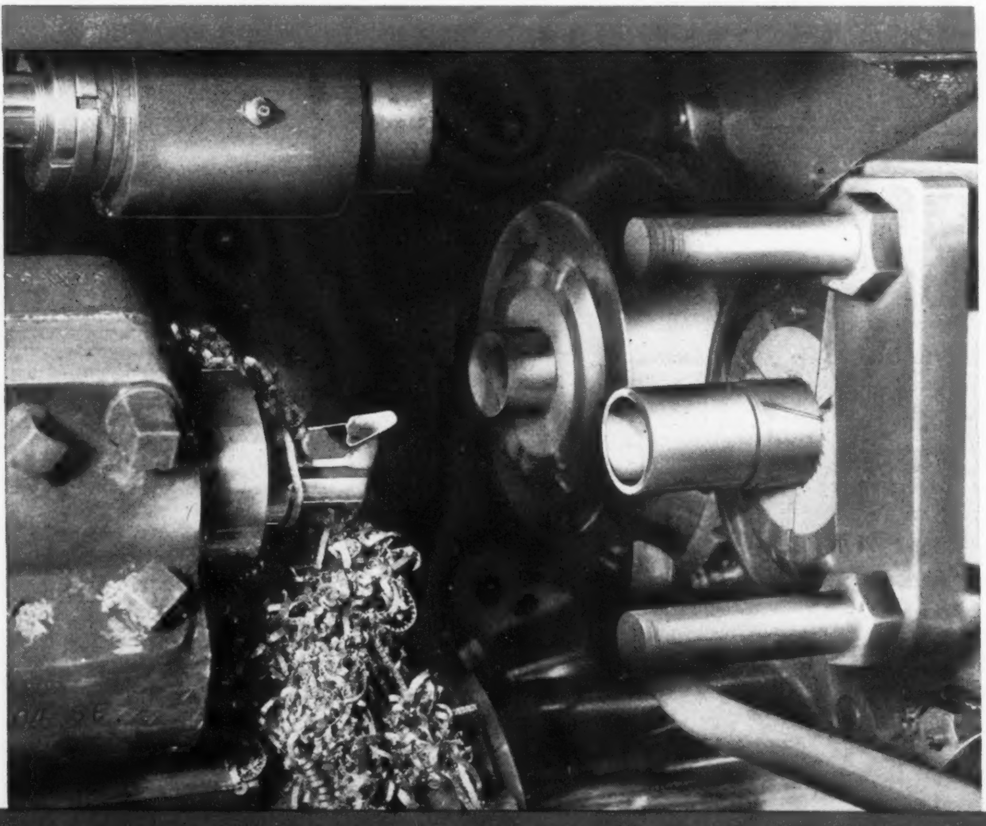
How to Chromium-Plate

Procedure Followed at the Springfield, Mass., Plant of the Westinghouse Electric & Mfg. Co. to Increase Tool Life with Consistent and Successful Results

SOME doubt has existed in the minds of tool engineers as to the advantages that can be derived from hard chromium-plating the cutting edge of tools. In discussing this subject with tool engineers, one often hears it said, "I have tried hard chromium-plating on cutting edges of different types of cutters with varying success, from a completely satisfactory plated tool to one that performs little or no better than an unplated tool. There seems to be no guaranteed consistency, but rather hit or miss results."

The tool engineer is often not clearly informed by the plater that special care is essential in grinding and lapping tools preparatory to plating the cutting edges, because the chromium deposit is influenced materially by the grain structure and hardness of the base metal. The tool engineer should understand, too, that it is exceedingly important that excessive strains developed in making the tool be relieved before plating and that the tool should be heat-treated after plating to relieve hydrogen embrittlement and prevent either the tool or the chromium plate from cracking.

Fig. 1. A Chromium-plated Tool Used in an Automatic Screw Machine Satisfactorily Performs a Boring Operation on Soft Steel Stock, whereas Chips Stuck and Welded to an Unplated Tool



for Greater Tool Life

By R. W. BENNET, General Foreman, and
C. HASTIE, Foreman, Westinghouse Springfield Plant

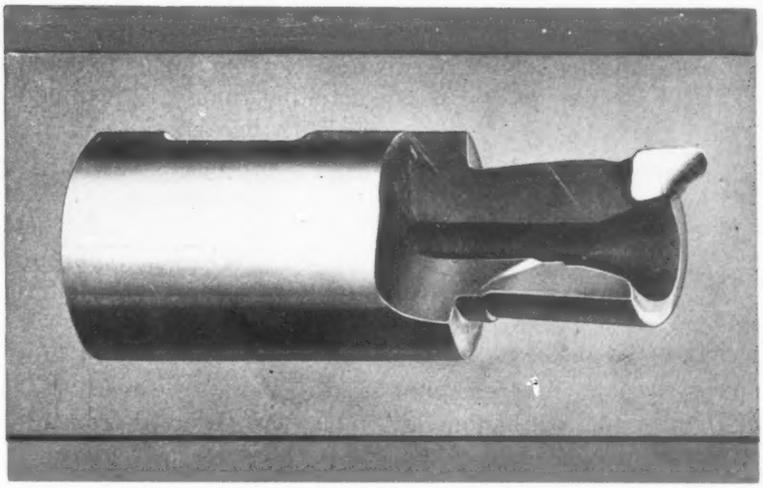


Fig. 2. Detail View of the Chromium-plated Boring Tool Shown in Fig. 1 in Use on an Automatic Screw Machine

On the other hand, in discussing the matter with experienced hard chromium-platers, it has been found that they usually possess little knowledge of the grade of steel being plated in individual instances or the exact nature of the material that the tools will be required to cut.

Generally speaking, therefore, when chromium-plated tools do not give desired results the blame rests about equally between the tool engineer and the plater. It is necessary to establish a common ground of understanding between tool engineers and platers so that their combined knowledge can be applied in making experiments and the reasons for success and failure fully understood.

In attacking this problem in the Westinghouse Springfield plant, equal consideration was given to the viewpoints of the tool engineers, toolmakers, platers, and the operators using the tool. This group carried on tests from the design to the use of chromium-plated tools, so that complete information as to the progress of a tool or performance in any trial was easily available. Because each member of the group had an equally important part in the program, unusually satisfactory results were obtained. How the group functioned can best be illustrated by describing several cases.

One of the most difficult problems was the case of a form tool for machining a cast-iron valve to extremely close tolerances at a fairly high production rate, considering the capacity of the machine available for the operation. The tool was first hard chromium-plated after being ground, with a resultant increase of 25 per cent in the life of the cutter before it became dull. Investigations were made along the lines of different plating thicknesses, strain relieving, lapping, and so on.

After a week of investigation, it was decided to make up a completely new tool based on all observations. The plater emphasized that there had to be ample support for the chromium plating, because, even though it had been proved

that chromium could stand up well under friction and abrasion, it was apparent that the plating had no great amount of tensile strength of its own. The plater also pointed out that careful stoning and lapping were necessary to give the tool an ideal base for the chromium plating.

Consequently, the toolmaker reduced clearances and rake on the tool below the usual standards in order to give all possible support to the plating. Although not seemingly important, he carefully stoned the tool in line with the chip flow of the material to be cut, and removed all sharp feather edges which gave no support to the chromium. The tool was then relieved of stress and heat-treated to a hardness of 60 Rockwell C.

A rack for holding the tool in the baths of the process was then constructed with anodes that conformed to the contour of the tool, so that the power (electric current) would be uniformly distributed to the tool. After proper cleansing, the tool was hard chromium-plated to a thickness of about 0.0001 inch, relieved of hydrogen embrittlement, and put on the job. Whereas previous production with an unplated tool had never exceeded 50 pieces per grind and had often averaged only between 35 and 40 pieces, it was found that from 1400 to 1600 pieces were obtainable per grinding and plating of the new tool. The cost of the hard chromium-plated tool seemed rather expensive off hand; however, it relieved a bottleneck by greatly reducing the number of machine set-ups, and saved approximately 360 pounds of tool steel in one year, paying for itself many times over.

There was another instance of a stepped machine reamer which lasted only from 10 to 16 hours in operation in an automatic screw machine in which close tolerances were extremely difficult to maintain. After changing the clearances on the cutting edges to give adequate support for chromium-plating, heat-treating the tool to proper hardness, and plating to a thickness of from 0.0001 to 0.00015 inch of chromium, machine runs of 175 to 200 hours were feasible.

With broaches, from six to ten times longer wear is obtainable from hard chromium-plated tools than from unplated ones. In the case of ball broaches, also, a far better finish is obtained on the work when chromium-plated tools are employed, due to the elimination of galling or scratching.

The experience with taps has been extremely gratifying. In several cases when under-size taps were received from the supplier, chromium to a thickness of between 0.001 and 0.002 inch was deposited on the cutting edges. However, it is not claimed that best tapping results can be obtained from plating of this thickness. The customary procedure is to use a tap for a short time and then give it a "flash" of chromium for its production run. In one operation in which an unplated tap produced from 3000 to 5000 pieces between grinds, 30,000 to 35,000 pieces are now obtained with a chromium-plated tap.

Reamers of both hand and machine types can be built up with from 0.001 to 0.002 inch of chromium if such a build-up is necessary due to wear or due to the fact that the tool is under size. This will give satisfactory results because reamers are not subjected to extreme cutting pressures.

Hard chromium-plating of bending, forming, and drawing dies for stainless steel is almost a necessity to prevent galling or fracture of the work. In one operation, unplated dies produced only from 20 to 25 pieces of stainless steel before galling or fracture of the work started.

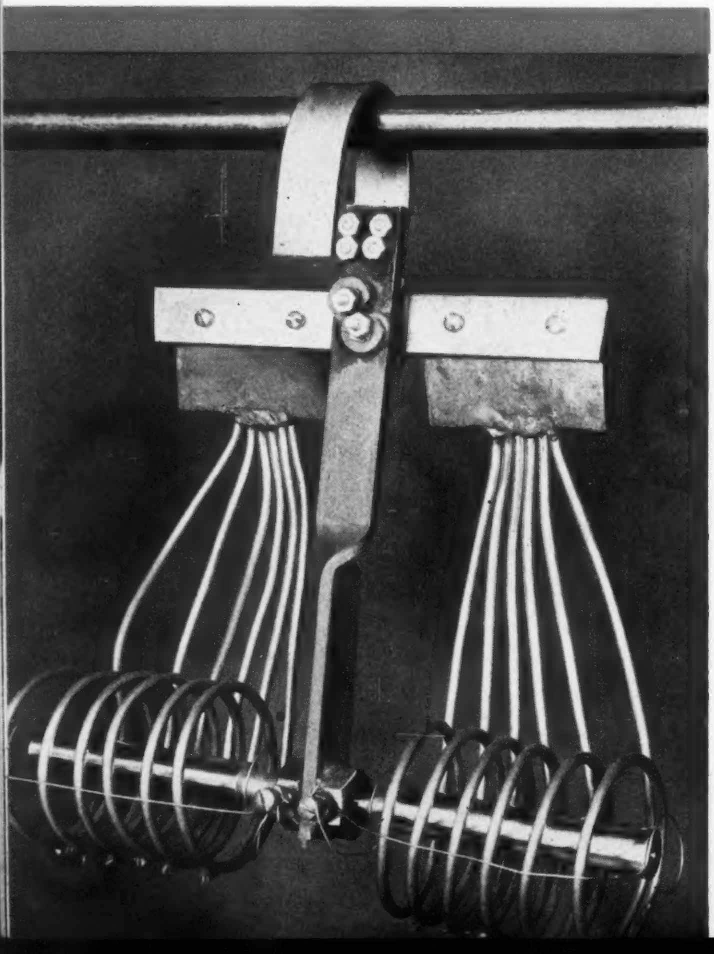


Fig. 3. The Racks Used in Chromium-plating Tools and Other Parts in the Springfield, Mass., Plant of the Westinghouse Electric & Mfg. Co., are Constructed with a Multiple Number of Anodes Conformed to the Shape of the Work-piece

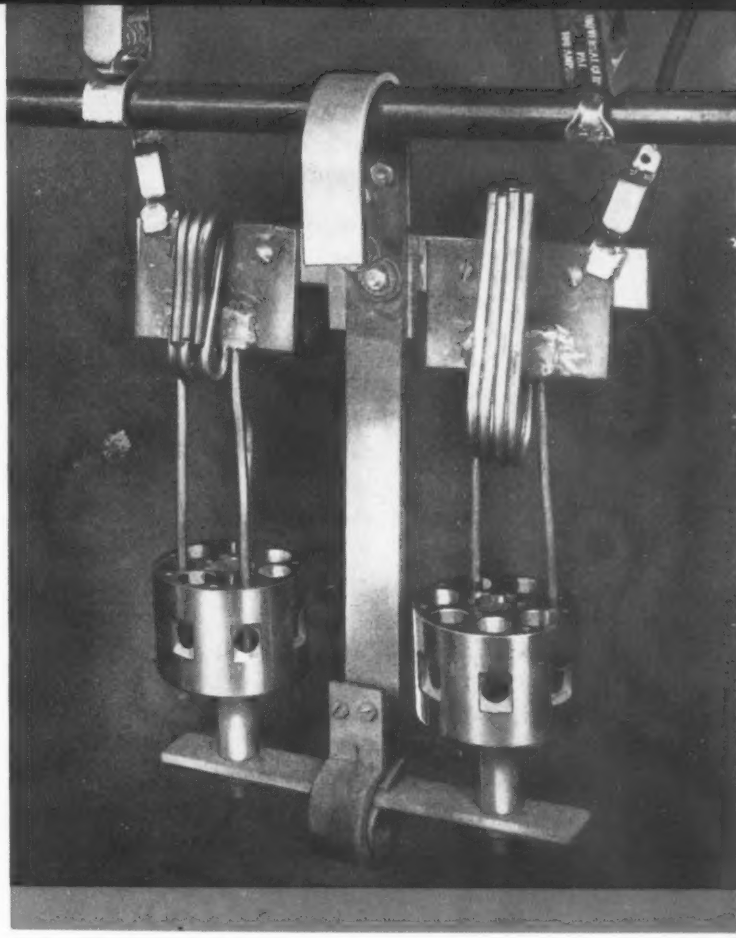


Fig. 4. Type of Rack Employed when Internal Surfaces must be Chromium-plated on Tools, Dies, and Other Parts

After the dies were hard chromium-plated to a thickness of 0.0002 inch and relieved of hydrogen embrittlement, a run of 5000 pieces was satisfactorily handled. Subsequently, another 5000 parts were turned out by the same dies with smooth surfaces, free from scratches or galling. Worn-out drawing dies have been built up as much as 0.015 inch with chromium, although such a heavy plating cannot be provided on all dies of this type because of the heavy drawing pressure required to form the work-pieces.

A boring tool used in an automatic screw machine for producing parts from bars of soft steel is seen in Fig. 1. This boring tool had to be chromium-plated because the chips stuck and welded themselves to the cutter, thus interfering with production. After the tool had been hard chromium-plated, the operation was performed satisfactorily. Fig. 2 shows the construction of this tool in detail.

Proper Rack Construction Necessary for Hard Chromium-Plating

Racks with multiple or "octopus" anodes conforming to the shape of the tools being plated have proved most satisfactory because they insure even distribution of the power (electrical current), and thus, even and controlled chromium-plating. The racks are constructed of copper and steel, several common Westinghouse types being shown in Figs. 3 and 4. These racks were designed for use in salvaging parts rather than for chromium-plating tools, but rack designs for tools would be similar.

It is advantageous to so construct the racks that the anodes and cathodes (the tools) are carried through the cleaning cycle, the reversed chromic acid etch, and the chromium-plating tank as one unit. It is important that proper insulation, either fiber or Micarta, be provided between the anodes and the cathodes, and all screws should be insulated with a piece of fiber tube or a Micarta washer.

The cathode portion of the rack which is immersed in the solutions should be made of steel and covered with a good lacquer to prevent the deposit of chromium on the racks. If brass or copper is used for the cathode, the copper content in the chromium bath may be dangerously increased by dissolution of the rack parts. The rod that holds the anodes and the hook on the cathode side of the rack can be made of 1/4-inch copper strap.

Successful hard chromium-plating depends about 80 per cent upon proper rack design. The anodes are made from lead-antimony alloy wires, which can be readily formed to the shape of the work to be plated. They are located from 1/2 to 1 inch from the work surfaces. Suitable wire can be purchased from almost any supplier of plating equipment, wire containing from 5.5 to 6.2 per cent antimony, from 1 to 5 per cent impurities, and the remainder, lead, being recommended.

A "thief" wire of soft iron must be placed about 1/4 inch from all edges of the tool being plated to prevent the building up of heavy thicknesses of chromium on the cutting edge. This "thief" wire must be cathodic. The "jumper" wires seen in Fig. 3 are battery clips for connecting the anode bar on the tanks to the rack.

Procedure Followed in Hard Chromium-Plating of Tools

The procedure followed in the hard chromium-plating of tools, as well as parts salvaged by depositing chromium to increase diameters, is as follows: (1) Degrease with solvent; (2) mount the tools on racks; (3) clean in an anodic alkali

bath held at a temperature of 82 degrees C. for from three to five minutes; (4) rinse in boiling water; (5) immerse in a 20 per cent hydrochloric acid solution for two to three seconds; (6) rinse in cold water; (7) rinse in hot water; (8) etch in a reverse-current chromic acid bath for two to five minutes; (9) place work immediately in the chromium-plating bath; and (10) remove hydrogen embrittlement, if necessary, by immersing the plated tools for two hours in an oil bath maintained at 177 degrees C.

Any alkaline cleaner can be used for the third step in the process, Oakite-test Q being used in the Westinghouse Springfield plant. Cleaners made from sodium hydroxide or sodium silicates are difficult to rinse from the work, whereas the ortho- and pyro-sodium phosphates can readily be removed during rinsing operations. Sodium carbonate solutions are satisfactory cleaners. Cathodic cleaning should not be employed. A boiling water rinse follows the alkaline bath because alkalies can be more readily removed by hot water than by cold water.

The purpose of the dip in hydrochloric acid solution, which is the fifth step in the process, is to remove any oxide films on the surface of the metal. Care should be taken not to over-etch the base metal, because excess immersion increases the possibility of hydrogen embrittlement in the base metal. The cold water rinse readily removes the hydrochloric acid.

The primary purpose of the hot water rinse is to raise the temperature of the work to approximately that of the chromium-plating bath which follows. The chromium acid reverse-etch bath should be held at from 52 to 55 degrees C. The chromic trioxide concentration should be approximately 200 grams per liter, or 26.8 ounces per gallon of water. The bath should contain no sulphuric acid. The work is the anode.

The work should be placed in the plating bath immediately after Operation 8, so as to prevent it from becoming dirty. It is preferable that electric contact be made immediately to prevent the slow dissolution of iron in the plating bath. It has been found that the ratio of chromic trioxide to sulphuric acid in the proportions of 84 to 1 gives the hardest chromium plate. The chromic trioxide concentration should be in the proportion of 53 ounces to 1 gallon of water.

The bath is analyzed every two weeks to determine the chromic trioxide and sulphuric acid content, and every six months for iron content. It is never checked for trivalent chromium ion, it being assumed from past experience that the ordinary "dragout" from the plating bath will keep this to the desired level. Iron concentration up to 10 or 12 per cent gives no trouble.

The copper content should be kept below six parts per million parts of solution. At ten to twelve parts of copper per million parts of solution, the "throwing power" of the solution is reduced to zero and the bath must be discarded. Every second day the specific gravity of the plating solution is determined and the chromium trioxide content estimated. The current density of the chromic-acid bath should be between 1 and 1 1/2 amperes per square inch at 52 to 55 degrees C., which gives a deposit of 0.001 inch of chromium per hour.

Elimination of hydrogen embrittlement (the tenth step in the process) is essential to prevent cracking of the chromium plate. All preceding operations are so laid out as to reduce hydrogen embrittlement of the base metal to the minimum, because it is difficult to relieve. Anodic cleaning and etching are resorted to in preference to cathodic operations. Any oil that can be maintained at between 175 and 177 degrees C. without decomposition can be used for the tenth step of the process.

The procedure followed in plating chromium on chromium is the same as in plating chromium on steel, except that the third step in the procedure is eliminated—that is, the anodic alkali bath.

For rechromium-plating over chromium plate, as on plug gages, the initial current density should be from 1/2 to 1 ampere per square inch, with a gradual increase to 1 or 1 1/2 amperes per square inch. However, with molybdenum steels, which cannot be plated under ordinary conditions, a current density of 100 to 150 amperes per square inch should be applied initially to "flash on" a chromium plate. Following this initial application, the current density should be decreased to normal values.

For chromium-plating on such surfaces as cutting edges, the base metal should have a hardness of between 56 and 58 Rockwell C, although a hardness of between 52 and 62 Rockwell C will be satisfactory. When the hardness is below 52 Rockwell C, distortion occurs in the base metal and the chromium plate will crack, whereas when the hardness is above 62 Rockwell C, the chromium plate tends to crumble.

Taper Line-Reaming Ship Drive-Shaft Flanges

By GEORGE D. BOWMAN, Chief Tool Engineer
Joshua Hendy Iron Works, Sunnyvale, Calif.

LINE-REAMING the tapered holes through the flanges of ship line and propeller shafts is a difficult operation to perform accurately under ordinary conditions and with standard tools. This operation is commonly performed with either a portable pneumatic drill or by hand. With either of these methods, perfect alignment is difficult to attain, a rigid set-up is rarely possible, and considerable time is consumed in performing the operation.

Equipment for doing this job in minimum time and with the holes reamed within a tolerance of 0.001 inch or less to receive fitted flange bolts has recently been developed by the Tool Engineering Division of the Joshua Hendy Iron Works, Sunnyvale, Calif. A patent to cover the equipment has been applied for. The equipment consists primarily of a portable machine tool which is mounted on a drive-shaft, as shown in Fig. 2, after the shaft sections have been set up on cradles or pedestals accurately in line with each other. The portable machine is mounted on the flanges of the lineshafts and is aligned with one of the holes which has been previously rough-drilled through both flanges to be joined. Close alignment is obtained by inserting a plug, such as seen second from the right in Fig. 1, into the flange holes next to the pair that are to be reamed.

Excess stock is then removed from the rough-

Fig. 1. Roughing, Semi-finishing, and Finishing Cutters for Taper Line-reaming the Flanges of Ship Drive-shafts, together with a Locating Plug and Tapered Gage for Checking Accuracy of Operation

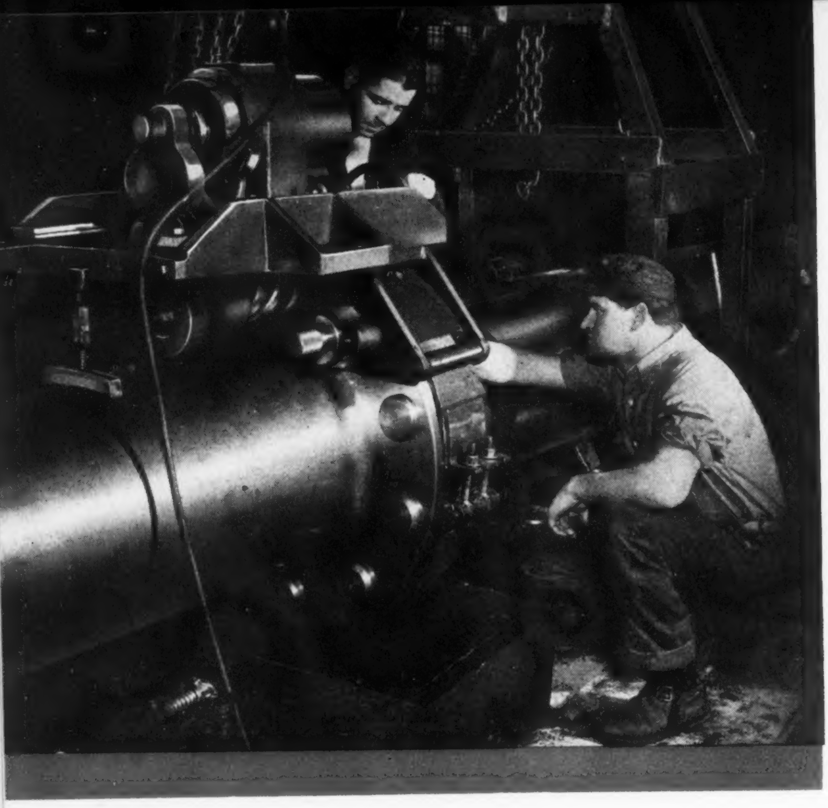
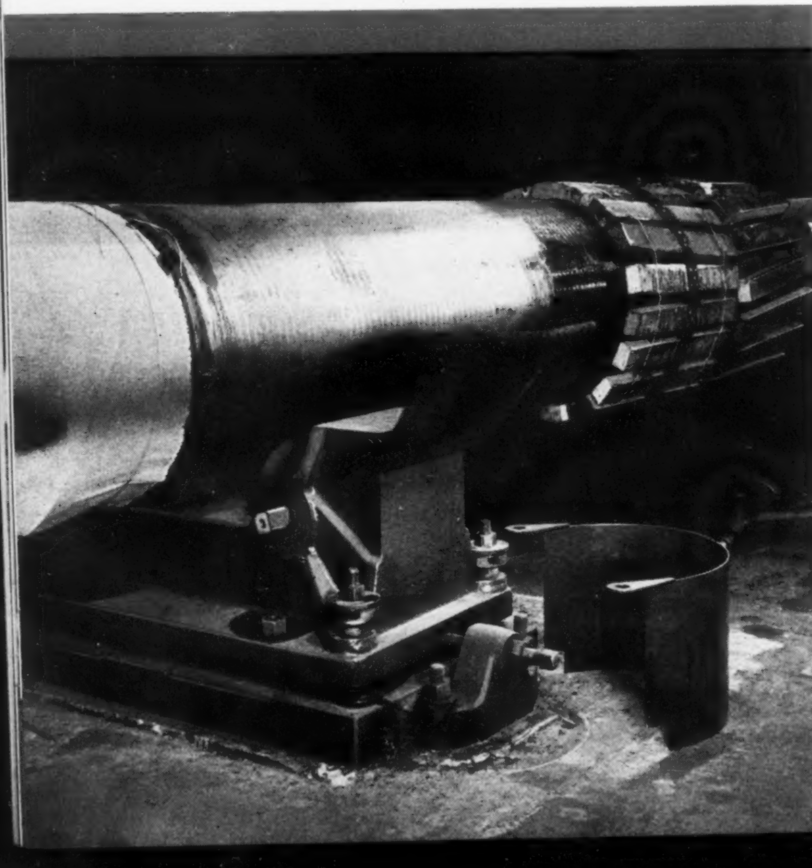


Fig. 2. Employing a Portable Motor-driven Unit which is Used in Connection with the Tools Seen in Fig. 1 for Line-reaming Bolt-holes in the Flanges of Ship Drive-shafts

Fig. 3. One of the Adjustable Cradles Employed for Lining up the Sections of Ship Lineshafts for Accurate Reaming of the Bolt-holes in the Shaft Flanges by Means of the Portable Unit Illustrated in Fig. 2



drilled holes by the use of a "porcupine" tool of the design shown in the center of Fig. 1. This tool is constructed with a solid body and has eighteen radial cutter bits spaced spirally around it. The bits project from both sides of the body and provide thirty-six teeth. The cuts taken by successive cutter bits overlap each other. The flange holes are machined the full length to a taper with a horizontal movement slightly more than the combined width of the two adjoining flanges, which is usually about 4 1/2 inches. The tool reams to within 1/16 inch of finished dimensions.

The semi-finishing reamer seen at the left of the porcupine tool is next mounted on the portable machine and fed into the flange holes for removing stock to within 0.010 to 0.012 inch of finished dimensions. After this, the sizing reamer at the extreme left is mounted on the machine for finishing the holes. This reamer is made with eleven flutes, which are unequally spaced so as to avoid the chatter that sometimes occurs with reamers having evenly spaced flutes. The semi-finishing reamer has seven flutes.

After one pair of flange holes has been finish-reamed, the locating plug is removed from the lineshaft flanges, the shafts are indexed to bring the next pair of holes approximately into line with the portable machine, and the locating plug is again inserted into a pair of holes. This procedure is repeated until all the holes are reamed.

The cradles or pedestals, also made by the concern, are equipped with elevating and adjusting screws for lining up the shaft sections prior to the reaming operation. Each of these cradles is equipped with cast rollers, as may be seen in Fig. 3, to facilitate indexing of the shafts. The portable reaming unit is ordinarily handled by a crane or chain hoist. After it has been lowered on the shaft flanges, it is rigidly clamped in place. A gear reducer drive powered by a 1 1/2-H.P. electric motor is mounted on the frame of the portable unit. The reamers are hand-fed. They are quickly installed and removed after the operation.

Power Required in Milling with Negative-Rake Cutters

Results of Investigations Conducted by the Research Laboratory of the Cincinnati Milling Machine Co.

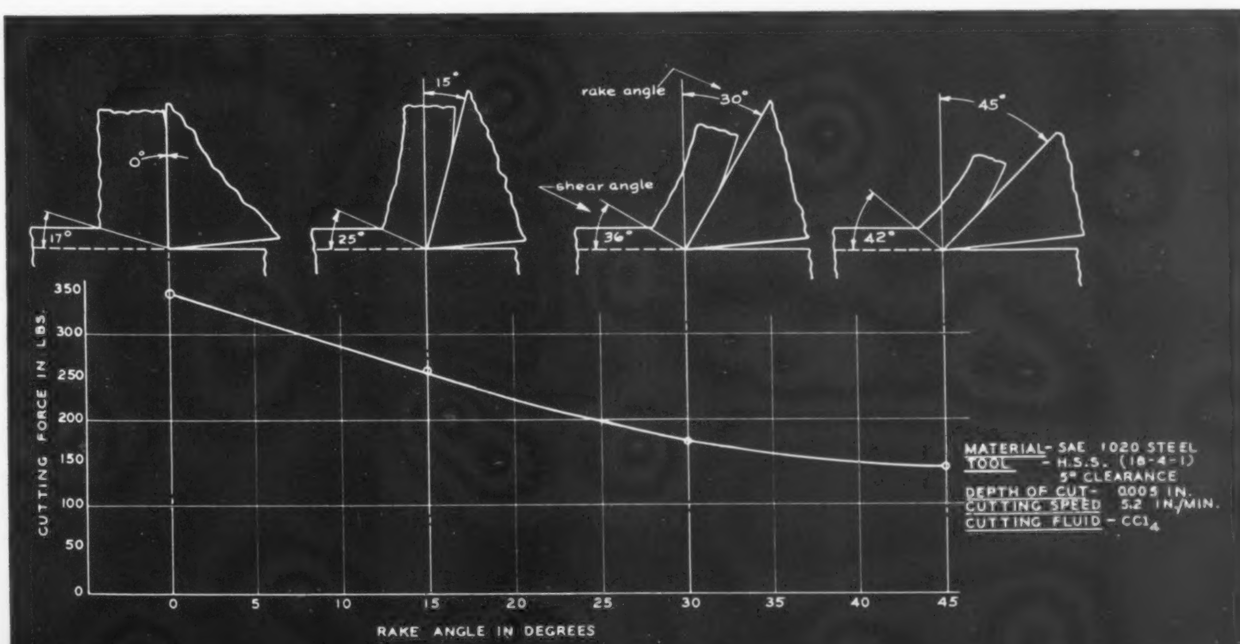
By HANS ERNST, Research Director

A FIFTEEN-YEAR dream of milling steel with carbide-tipped milling cutters has become a reality with the development of negative-rake cutters. At first sight, the astonishing results obtained by applying this new practice appear directly opposite to previously known metal-cutting theory. The stronger tooth form obtained with the negative rake angle is a definite advantage, but it would seem to be more than offset by less effective cutting action, as investigations have shown that the power required to remove metal increases greatly as the conventional positive rake angle is decreased.

This is indicated by Chart 1, which shows the relationship between cutting force and positive rake angle for one particular set of conditions. The relationship shown is typical of that encountered in practice with the cutting speeds usually employed when high-speed steel cutters are used.

From this diagram, it would seem that if the rake angle were made negative, there would be a still further increase in the required cutting force and consequently in the power necessary to remove a unit volume of metal. Recent metal-cutting research indicates, however, that while

Chart 1. Diagrams and Chart that Show how the Cutting Force of High-speed Steel Cutters Increases as the Positive Rake Angle Decreases



the power for tools with negative rake angles is high when the cutting speed is low, this is not true when the cutting speed is high.

Careful investigations over a wide range of speeds and with various work materials have shown that the power required with negative rake angles decreases steadily with increase in speed. In fact, it has been found in several cases that beyond a certain speed, the specific power consumption with negative rake angles is actually less than with positive rake angles.

If this should prove to be universally true, then it follows that as permissible cutting speeds reach still higher values through the development of still better cutting tool materials, the negative rake angle will have an increasing advantage over the positive rake angle, not only because of the greater inherent strength provided by it, but also because of the lower power consumption incident to its use.

Chart 2 was made in May, 1942, by Dr. M. E. Merchant and Mr. N. Zlatin from data obtained with a special machinability dynamometer constructed in the Research Laboratory of the Cincinnati Milling Machine Co. From this chart it will be noted that while there is a marked decrease in the cutting force with increase in speed in the case of a tool with a 10-degree negative rake angle, there is actually a rise in the cutting force with increase in speed in the case of a tool with a 10-degree positive rake angle. At a speed of approximately 730 feet per minute, in this particular case, the cutting force is identical for both positive and negative rake angles, while at still higher speeds the force is less for negative rake angles than for positive rake angles.

Additional evidence to substantiate this relationship has since been obtained in investigations with other materials, as illustrated in

Chart 2. This Chart Indicates that the Cutting Force Required for Negative-rake Cutters Actually Becomes Less at High Speeds than the Cutting Force Required for Positive-rake Cutters. There is a Speed Value where the Cutting Force is the Same for Both Positive and Negative Rake

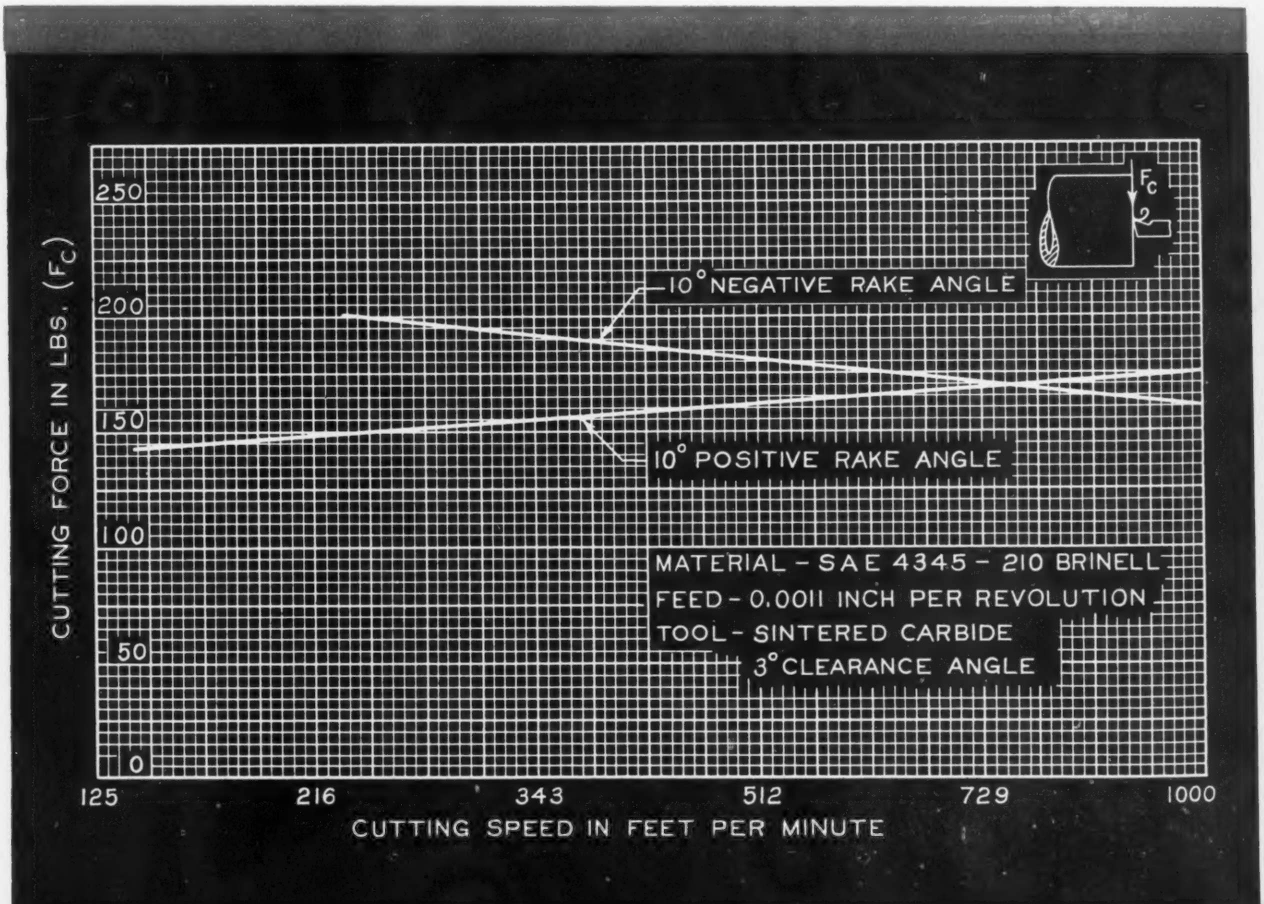


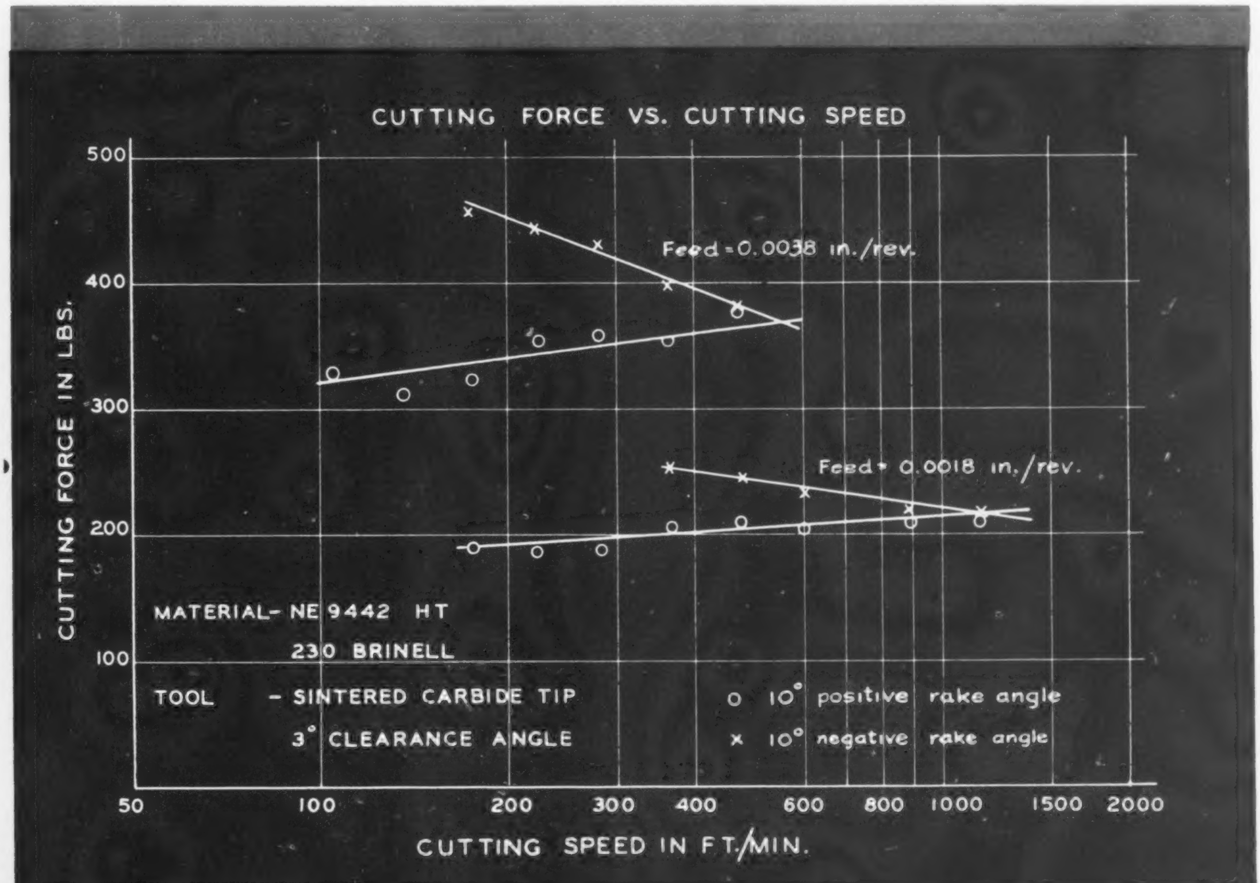
Chart 3. In every case, there has been found a marked decrease of cutting force with increased speed for negative rake angles, and a speed value where the cutting force was the same for both positive and negative rake. It will also be noted from this chart that this speed value was not constant, but varied with the cutting conditions, being lower when the feed per revolution was larger. This chart shows two tests conducted on one material at different cutting speeds and feeds; a number of other tests were performed on other materials and under various conditions of speed and feed with similar findings. All these tests were made with a single-point tool cutting on the end of a tube. However, a similar relationship was found with high-speed milling cutters operating on both steel and aluminum.

Relationships such as presented in these charts raise the inevitable question, "Why?" While the complete answer is not known, it is clear that the key to the answer lies in the large reduction both in the coefficient of friction and the force of friction between the sliding chip and the tool face obtained with the combination of high speed and negative rake.

The use of negative rake angles and high speeds is not a fad of the moment, but represents a real advance in milling procedure; as stronger carbides are developed, still higher cutting speeds may be used, with perhaps even higher feed per tooth than possible with present carbides, thus permitting still more efficient metal removal.

[This article is abstracted from a paper "High-Speed Milling with Negative Rake Angles," which was presented by Dr. Ernst as part of a symposium on high-speed milling at the recent annual meeting of the American Society of Mechanical Engineers.—EDITOR]

Chart 3. Another Chart that Indicates a Marked Decrease in the Cutting Force with Increased Speeds for Cutters of Negative Rake Angle. The Speed Value where the Cutting Force is the Same for Both Positive and Negative Rake Varies with the Feed, as Indicated by the Two Examples



Editorial Comment

This is a good time for house-cleaning in all industrial plants. A clean and neat shop is commendable in itself, but at the present time there is a far more pressing reason for such house-cleaning. Scrap is needed for producing the materials with which to produce war equipment. Not only steel and cast-iron scrap are urgently needed, but also copper, brass, and bronze. Steel scrap is always needed to keep the steel mills going, and copper and other metal scrap is equally important.

A House-Cleaning in the Shop Will Help the Scrap Drive

In spite of all that has been accomplished in collecting scrap in industrial plants, there are many machine shops that still have material lying around that is not likely to be of any use in the shop's production work, but that would be useful as part of the nation's scrap pile.

★ ★

To adequately meet the problems ahead when the war has been won, business, labor, and Government must all assume a broad and tolerant attitude. If we are to realize all the possibilities of this nation in the future, there must be a willingness of different groups to discuss their problems on a basis that subordinates political and class prejudices and antagonisms to the national welfare. There must be a willingness to cooperate in promoting a national program that excludes pressure groups and class interests. The problems are not easy of solution. There is room for much study to arrive at clear conceptions of the underlying factors.

A Great Team if They Would Pull Together

As stated in a recent publication by Stevenson, Jordan & Harrison, there is a lack of understanding on the part of a great many business men concerning the proper relationship of each individual business to the national economy as a whole, as well as of the problems with which business will be confronted after the war.

On the part of labor and labor leaders, there is a lack of understanding of the kind of relationship with business management that will most effectively promote the interests of the members of labor organizations. As yet, it does not seem to have become fully understood, except by a few unions, that the highest wages and the highest standard of living are a direct result of a prosperous industry.

Finally, there is much room for a better understanding on the part of those who compose Government of the essentials that promote the welfare and prosperity of the entire nation. The part played by industry in the national prosperity is not clear to many men in high office.

If business men, labor leaders, and Government office holders should ever come to work together for the welfare of the nation as a whole, the United States would be capable of accomplishing results of which the boldest dreamers of today can hardly conceive.

★ ★

It is likely that automatic machinery will be used to an ever increasing extent in the peacetime industries after the war, because only by so doing can costs be reduced so that the products of industry can be sold at a reasonable price. This will be especially necessary to offset the much higher wage level that has been reached during the war and that is not likely to be materially reduced. With higher wages, the only way in which the products of labor can be sold without increasing prices is by making labor more productive through the use of improved machinery.

Automatic Machinery Needed More than Ever after the War

Weekly money wages in industry have risen more than the cost of living during the past few years. This has resulted in a great increase in the weekly purchasing power of the average industrial worker. If this ratio continues after the war, the nation's purchasing power will be high, and the demand for goods offered at reasonable prices, made possible by the use of automatic machinery, will steadily increase; hence, automatic machinery is the only answer to the problem of high wages and low-priced goods.

Laura A. Brownell (Mrs. L. A. Bell)

MANY advertising and other executives in the machinery field will experience a keen sense of personal loss on learning of the death of Mrs. Laura A. Bell (Mrs. L. A. Brownell in private life) on January 22. Mrs. Bell was one of the pioneers of The Industrial Press staff. Her energy, imagination, integrity, and keen intelligence not only won the admiration and respect of all who knew her, but contributed much to the advancement of industrial advertising.

Forty-six years ago, when Mrs. Bell joined The Industrial Press, business publishing was in its infancy and industrial advertising little understood and recognized even less as a potentially powerful economic factor. Naturally attracted to advertising because of her ability as a writer combined with artistic ability and judgment which proved highly useful, Mrs. Bell very soon made a reputation for herself which later spread out to a wide circle of business friends and acquaintances who came to her with their advertising problems. In the days when women in business were the exception rather than the rule and more tolerated than welcomed, this achievement was a more than ordinary mark of rare ability and force of character.

Starting from "scratch," with no previous business experience, and joining a small struggling publication that was only a few years old, Mrs. Bell soon acquired a practical knowledge of the industry served by MACHINERY, along with the technique of industrial advertising, and as the publication grew, she grew with it and was herself responsible for no small part of that growth. For many years she was advertising manager of MACHINERY, and developed many novel and effective advertising ideas that did much to increase the interest and quality of copy and design in MACHINERY'S advertising.

A loyal and highly capable member of The Industrial Press staff, a staunch friend and a vigorous personality which never failed to leave its impress, Mrs. Bell occupied a special niche in the affections of all her business associates and friends.

National Society of Plastic Tooling

The National Society of Plastic Tooling has been formed by representatives of five large aircraft firms in the eastern part of the United States. The new society was organized at a meeting held early in February in New York.

Delmar Anderson, superintendent of production planning and tool design for the Curtiss-Wright Corporation's Buffalo plant, was elected president of the society; Thomas A. Herbert, superintendent of the plastic, plaster, and foundry departments of the Consolidated-Vultee Aircraft Corporation's Allentown, Pa., plant was elected vice-president; Harry W. Tomkins, of the Curtiss-Wright Buffalo plant, secretary; and Charles H. Miller, of the Bell Aircraft Corporation, Buffalo, treasurer. Membership is open on a national basis, and a national meeting will be held at a later date.

Importance of Conservation of Paper

The War Production Board is urging everyone, including manufacturing establishments, to conserve paper to the greatest possible extent, and particularly to salvage paper whenever possible. Enormous amounts of waste paper that could be put back into production are still being discarded in many shipping and receiving departments, warehouses, and offices.

Outgoing shipments should be wrapped as economically as possible, and the wrapping from incoming shipments should be saved, bundled, and disposed of so that it can be put back into the paper industry. It is hoped that 8,000,000 tons of waste paper per year may be collected by the various salvage branches. All cartons, corrugated paper, waste-basket paper, discarded file material, and discarded catalogues should be saved and bundled for that purpose.

Renegotiation and the Small Manufacturer

By One Who Has Been Renegotiated

As a manufacturer having a comparatively small machine shop, who has devoted most of his efforts during the last two years to the production of important accessories used in the manufacture of war material, I read with considerable interest the editorial in February MACHINERY on renegotiation. I was especially impressed by the sentence that referred to the difficulties of the smaller manufacturer.

In the case of small firms, renegotiation has sometimes been a severe shock. At the insistence of various government agencies, the proprietors of small plants have spent their surplus cash to buy new equipment and sometimes to make additions to their shops, in order that they might produce more rapidly the equipment needed for the war effort.

Then, when renegotiated, in some instances they have had to go out and borrow the money with which to pay the renegotiation assessment. One owner of a medium-sized jobbing shop says that if he is renegotiated for his 1943 business as severely as he was for his 1942 efforts, he will be forced out of business, because he will have no working capital left.

The Government says that their old jobs will be waiting for the servicemen when they return; but how can the jobs be waiting for them if the shops are no longer there? The reconversion to peacetime business will be difficult enough in any case. It will be well nigh impossible for a small firm that has no working capital left after having paid the renegotiation assessments.

The one point that should be emphasized is the fact that, unlike taxes, these assessments cannot be estimated in advance by the manufacturer. The actual assessment is often made considerably more than a year after the contract has been completed. A year and a half ago, none of us knew exactly what this renegotiation meant; otherwise, we could have endeavored to make financial provisions for it. As it is, it has caught many of us unawares, and after having paid the assessment, we are without working capital.

Another point that should be emphasized in this connection is the fact that the only people who are being called upon to pay something additional to their regular taxes because of added business due to the war are the manufacturers who have exerted themselves to do a real good job in the way of producing equipment for the prosecution of the war. There are any number of other businesses where there are even greater so-called "excess profits" resulting from the war that are untouched by any renegotiation proceedings.

Take the jewelry trade, for example. The sale of diamonds has increased tremendously; profits have been very great. Both the increased sales and the increased profits are direct results of the increased earnings of workers due to the war; yet the renegotiation net does not reach these war profits. Similarly, the fur business, liquor business, the hotel and restaurant business, and semi-luxury businesses of all kinds have profited because of the war; but the excess profits in these businesses are not subjected to the special assessments that are laid upon the manufacturers who have contributed most to the success of the war effort.

Make the excess profits tax anything you like so long as the amount of the tax can be determined in advance and a uniform method of assessment makes it possible to levy on each business according to set rules and formulas, enabling each business to determine for itself what its share of taxes is. But let us abandon the un-American method of arbitrarily levying taxes in amounts not determined by any set rule or formula, but based on what a small group of men concludes would be about right. Such arbitrary methods smack of dictatorship; we are fighting dictatorships, and we should not tolerate them at home.

* * *

Machine Tool Shipments and Orders

Shipments of machine tools during December, according to the Office of War Information, were valued at $60,680,000, or at an annual rate of approximately $725,000,000. The net new orders received by the machine tool industry in December were valued at $26,800,000, which is at an annual rate of approximately $320,000,000. By "net orders" is meant total new orders less cancellations during the month. While this is but a fraction of the maximum machine tool orders placed in 1942, it is 60 per cent in excess of the machine tool business in the largest peacetime year. The backlog of unfilled orders at the end of December amounted to a total of $211,750,000. At the rate of shipments in December, this represents approximately three and one-half months business.

Ingenious Mechanical Movements

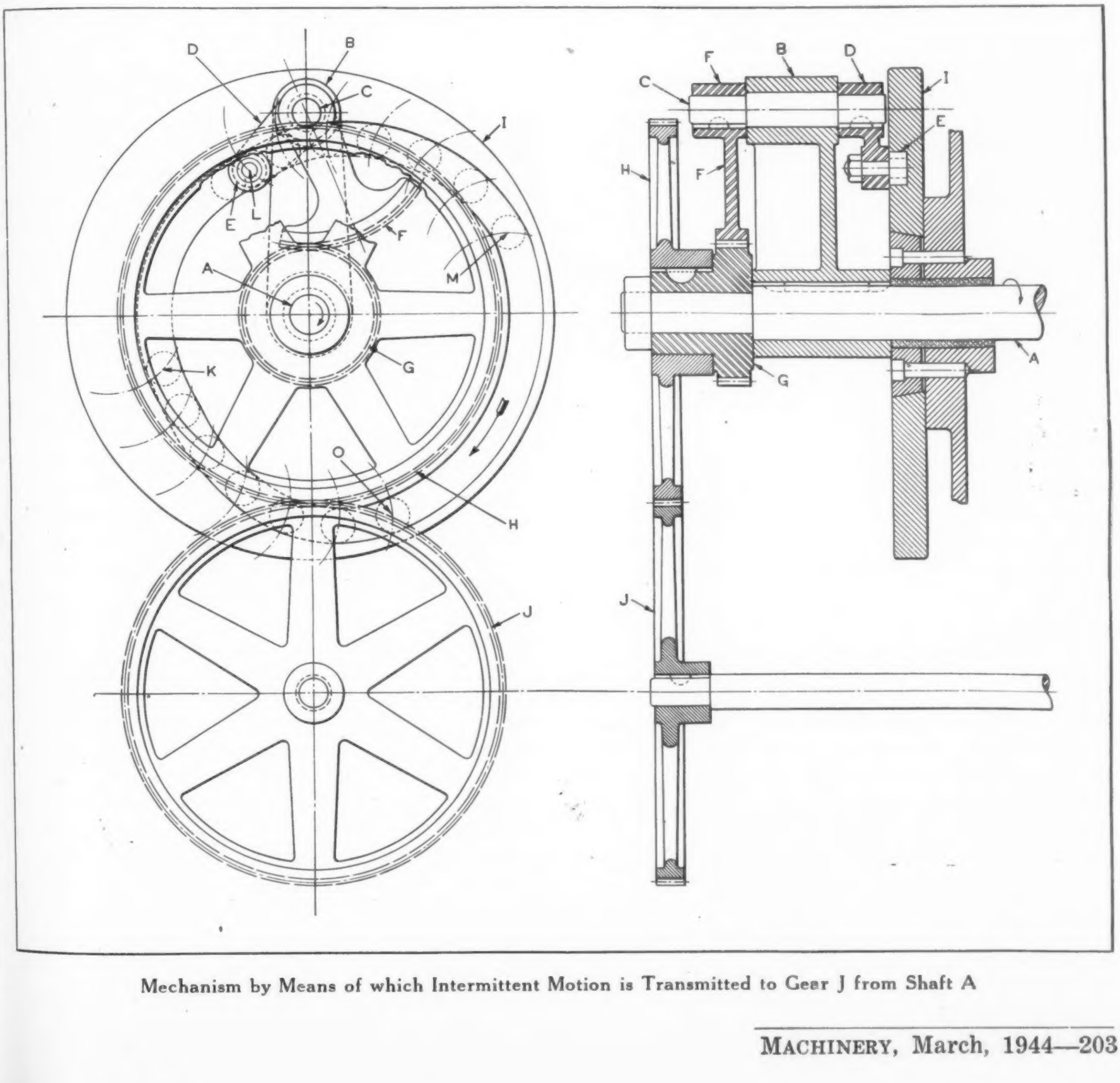
Mechanisms Selected by Experienced Machine Designers as Typical Examples Applicable in the Construction of Automatic Machines and Other Devices

Intermittent Rotary-Motion Mechanism

By CHARLES F. SMITH

Shaft *A* of the mechanism shown in the accompanying illustration, rotating in a clockwise direction at a constant speed, is required to transmit intermittent rotating motion in a counter-clockwise direction to the driven gear *J*. Shaft *A* is keyed to a driving arm *B*, which carries a short shaft *C*. Keyed to one end of shaft *C* is a crank-arm *D* with a cam-follower roller *E* which, traveling in a groove in the stationary base cam *I*, transmits an oscillating rotary motion to shaft *C*.

To the front end of shaft *C* is keyed a segment gear *F*, which is in constant mesh with gear *G*. Gear *G* is a running fit on shaft *A*, and has a hub to which gear *H* is keyed. Gear *H*, in turn, is in mesh with gear *J*, keyed to the shaft that is to be given the intermittent rotating motion. Since gear *J* has the same number of teeth as



Mechanism by Means of which Intermittent Motion is Transmitted to Gear J from Shaft A

gear H, it will have the same intermittent motion, but rotation will be in the opposite direction, or counter-clockwise.

Referring to the view to the left in the illustration, it will be clear that so long as the cam-follower roller E is traveling in the concentric portion of the cam groove from K to L, there will be no rotary motion of shaft C in arm B. During this period, arm B and segment gear F simply transmit rotary motion to gear H in a clockwise direction at the same speed as that of shaft A. Thus, so long as there is no rotary motion of shaft C in its bearing in arm B, the latter member, together with segment gear F and the gears G and H, are effectively locked together and rotate as a single member.

When shaft A and arm B, rotating in a clockwise direction, cause the follower-cam roller E to travel from L to M, the rise in the groove of cam I causes segment gear F and its shaft C to rotate in a clockwise direction in arm B. Since segment gear F is in mesh with gear G, a rotating motion is transmitted to gears G and H in a counter-clockwise direction, which is opposite to the clockwise rotation imparted to them by arm B alone.

Now, since the counter-clockwise movement imparted to gears G and H by segment gear F is equivalent to the clockwise movement imparted by arm B alone in making the quarter revolution required to carry roller E from L to M, gears G and H will remain idle during this period. To obtain this intermittent or idle period, the rise of the cam groove from L to M must be just sufficient to cause segment gear F to transmit counter-clockwise motion at the same rate as the clockwise motion transmitted by arm B.

Continued clockwise movement of arm B during the next quarter revolution carries roller E from M to O. As this portion of the groove in plate I is concentric with shaft A, there will be no rotation of the segment gear in arm B, and shaft A, arm B, segment gear F, and gears G and H will again revolve as one unit through one quarter revolution.

During the next quarter revolution of shaft A, in which roller E travels from O to K, the fall in the cam groove will cause segment gear F to rotate in a counter-clockwise direction, and, consequently, transmit motion to gears G and H in a clockwise direction, which is in the same direction in which arm B is driving these gears. Therefore, in this case, the driving motion imparted to gears G and H by segment gear F is added to that imparted by arm B alone, thus doubling the rotating speed of gears G and H during this quarter revolution of shaft A. Gears G and H are, therefore, rotated through an angle of 180 degrees, while shaft A rotates through an angle of 90 degrees.

Summarizing the operation of the intermittent action of the mechanism, rotation of driving shaft A at constant speed has the following results: There is no movement of gears G, H, and J while arm B carries roller J through one-fourth revolution from L to M; the driven gears rotate at the same speed as shaft A and in the same clockwise direction while E travels from M to O; the driven gear J rotates at twice the speed of shaft A in a counter-clockwise direction while E travels from O to K; the driven gears rotate at the same speed as the driving shaft A while roller E is carried from K to L. The angular position of shaft A and arm B at which the dwell period of gear J begins can be varied by adjusting cam I and clamping it in place when the proper adjustment has been made.

* * *

New Electric Motor Operates at 120,000 R.P.M.

An electric motor operating at the record-breaking speed of 120,000 R.P.M., or 2000 revolutions per second, has been built and tested by the General Electric Co. The motor was developed for application to internal grinding machines used in finish-grinding small holes—many less than 1/4 inch in diameter. The surface speed required to produce a high-grade finish economically by grinding should be about the same, whether grinding a large or a small hole. Hence, for small holes where only a very small grinding wheel can be used, a high rotating speed is essential. Although the motor will not be available for general use until after the war, another possibility for its use is the drilling of tiny holes in metal with drills 1/32 inch in diameter and less.

With normal voltage applied at 2000 cycles, the new motor reaches full speed in less than a second. It is rated at 3 H.P., and weighs but 7 pounds, as contrasted with the standard 3-H.P., 1800-R.P.M. motor which weighs 105 pounds. The motor is so small that it can be held in the palm of the hand, while its rotor is scarcely larger than a man's thumb.

The motor has successfully passed tests at 120,000 R.P.M., including eight-hour continuous runs at rated horsepower, as well as grinding tests with a tiny grinding wheel mounted directly on the motor shaft.

The problems entering into the design of the motor were largely of a mechanical nature. Ultra-precision bearings and practically perfect dynamic balance were required. A special oil-mist lubricated type of bearing is used. The amount of material used in the motor is so small, with a consequent reduction in radiating surface, that water cooling is utilized.

Production Control in Aircraft-Engine Manufacture

By PAUL J. BASTIAN, Production Manager
Wright Aeronautical Corporation, Paterson, N. J.

THE planning of the material flow through a department and the scheduling of the various lots in such a manner as to assure an uninterrupted supply of completed parts to the assembly department are normally considered duties of the department foreman. At the plants of the Wright Aeronautical Corporation, however, the tremendous expansion occasioned by the war effort has so greatly increased the foremen's responsibilities that it is no longer possible for them to handle this work in addition to their other duties. A special unit has, therefore, been established in each department under the control of a production planner, who acts as staff assistant to the foreman and works very closely with both materials planners and expeditors.

It is the function of these production planners and their assistants, who may number as many as six in a large department, to so arrange the flow of parts through the department that the prearranged schedules will be met at all times. They are required to know from hour to hour the exact location and condition of each production lot and to make immediate decisions as to which parts should be assigned to a particular machine when it becomes available.

The procedure varies somewhat in each department according to whether the equipment is arranged for straight-line production of a single part, as in the case of cylinder barrels, or grouped according to machine type, as in the gear department, where a wide variety of different gears must be manufactured.

In either case, the first step consists of establishing certain control points through which the flow of parts can be checked. All gears, for example, are heat-treated, either by carburizing or nitriding; and since these processes are confined to certain specific parts of the gears, copper- or tin-plating must be employed for stop-off. The plating room, therefore, forms a natural control point. Certain parts may pass directly to the heat-treating room, while others may return to the machine shop for additional turning, drilling, grinding, or gear-cutting; but eventually, nearly every part must pass through the heat-treating room, where a second control point is established.

Because of the time required to complete the parts, gears are usually started in process about three months ahead of the scheduled completion date, and a sufficient quantity must always have been plated to cover two months' requirements, and heat-treated, after secondary operations, to cover one month's requirements. The numbei of operations to be performed prior to plating, between plating and hardening, and after hardening varies with each particular part; but through long experience and knowledge of the processes involved, the planners are able, by comparing the quantities plated and the quantities heat-treated with the weekly requirements on the schedule, to determine which parts are behind schedule. They are then in a position to decide on the order in which these should be assigned to the various machines becoming available for the next operations.

Each lot of parts is accompanied by a linen routing tag, or "traveler," on which the operation sequence is mimeographed, and as each operation is performed, the "traveler" is punched.

SCHEDULE DATE 12/26/42					WEEK END.	WEEK END.	WEEK END.	WEEK END.	WEEK END.	WEEK END.	WEEK END.	WEEK END.	WEEK END.	WEEK END.	MONTH OF FEB	MONTH OF MARCH	MONTH OF APRIL
PART NO.	MATERIAL	MODEL	UNIT	NAME	1/2	1/9	1/16	1/23	1/30	2/6	2/13	2/20	2/27	3/6			
73246	73246F	832X	1	Gear	50	50	50	50	50	50	50	50	50	50	350	100	100
53427	AMS 412	982	4	Pinion			28		28		28		28	28	140	140	160
27268	27268F	982	1	Shaft	100	100	100	100	100	100	100	100	100	100	900	900	800

Fig. 1. Departmental Schedule Sheet Used in Conjunction with Sheet Shown in Fig. 2 to Indicate Work Started in Process

SCHEDULE DATE 12/26/42					WEEK ENDING	WEEK ENDING	WEEK ENDING	WEEK ENDING	WEEK ENDING	WEEK ENDING	WEEK ENDING	WEEK ENDING	WEEK ENDING	WEEK ENDING	MONTH OF FEB.	MONTH OF MARCH	MONTH OF APRIL
PART NO.	MATERIAL	MODEL	UNIT	NAME	1/2	1/9	1/16	1/23	1/30	2/6	2/13	2/20	2/27	3/6			
73246	73246F	832X	1	Gear	50	50	50	50	50	50	50	50	50	50	350	100	100
53427	AMS 412	982	4	Pinion			28		28		28		28	28	140	140	160
27268	27268F	982	1	Shaft	100	100	100	100	100	100	100	100	100	100	900	900	800

Fig. 2. Departmental Schedule Sheet Showing Progress of Work in Process

At the beginning and end of the operation on each particular lot, the operator is required to report to the timekeeper for the stamping of his job card, and the information on this card is then recorded on the back of the shop order retained in the assignment crib. These two records, which must, of course, agree, form the basis for a perpetual inventory.

Theoretically, the number of parts shown on this inventory plus the number on the unstarted orders in the assignment crib should equal the total number released, as shown on the "tub-desk" records. In order to make sure that these records agree, the planners take a physical inventory every two months, when the new departmental schedule is delivered.

Each part in process is checked and its condition in relation to the control points is noted. Thus, in the gear department, it will be noted how many parts have been started in each lot, how many have passed through the plating department, and how many through the hardening department. These figures can then be compared with the schedules, and, if necessary, certain parts may be given precedence. Similarly, if the scrap losses on a certain part are above average, a new lot can be started in production.

Records of Progress of Work

A visible record of the progress of each part is maintained by means of lines (preferably colored) drawn on the departmental schedule sheets, Figs. 1 and 2. For example, if for a certain part, the inventory shows that 1000 pieces have been started in process, green lines are drawn on the chart (Fig. 1) opposite that particular part number and extended a sufficient distance to cover the requirements of 1000 pieces. Then, supposing that 500 of these parts have passed through the plating department (the first control point), but not through the hardening department (the second control point), red lines are drawn on a second copy of the schedule (Fig. 2) for a sufficient distance to cover the requirements of 500 pieces.

Similarly, blue lines are drawn on a third copy to indicate how many have passed through the hardening department, and, finally, black lines are drawn on a fourth copy to show the quantity delivered to the finished stores. These color charts are kept up to date each day from the data furnished by the daily reports. It is thus a simple matter for the planners to see at a glance the status of any part, and to determine when additional quantities should be started and the urgency with which parts should be advanced through the various operations.

Dept. 24		Date 12/27/42
Turret Lathes	Job Running	Job to Follow
731	72346	89742
732	72346	63572
733	92846	23475
827	23987	34867
829	14596	34867
901	23785	34867
902	76592	43524
Gear Cutters	Job Running	Job to Follow
215	72387	12469
216	76592	35687
217	92846	98532
346	23567	50943
347	98762	56890
352	78953	70982

Fig. 3. Machine Schedule

Application of the System to Gear Production

The gear department furnishes a good example of the way in which this system works, since it combines three different divisions—the turning section, the line section, and the miscellaneous section. In the turning section, the planner is concerned with the green schedule (Fig. 1) for parts starting in process, with the red (Fig. 2) for those that have passed through the plating department, and with the blue for those that require additional machining after plating, but before hardening. He has no direct interest in the black schedule, since parts never return to his section after hardening.

From the green schedule, he determines exactly when he must start new lots in production in order to keep the number in process equal to three months' requirements. The relative lengths of the green lines for different parts also indicate which parts should be given priority when the first operations are performed on the same machine. The lengths of the lines on the red and blue schedules similarly indicate which parts are behind in production, and these records assist in establishing priorities in the turning section.

With the priorities thus established, the planner draws up a machine schedule (Fig. 3) listing each machine in his section and the part number of the job in process. He then assigns the next job to each machine in the order of its importance. In this connection, he is guided by his own experience of machine shop practice, and by consultation with the foremen. Whenever possible, he tries to avoid major tool changes, in order to conserve set-up time, but when a job is really urgent, he does not hesitate to request a complete tool tear-down.

If, for example, a certain machine is running on part 12536, operation 10, which is similar to part 73564, operation 15, and part 84675, operation 10, the planner knows he can assign either of the two latter parts to that machine, depending on their relative importance. In case an entirely different part is urgently needed, however, it may be routed to this particular machine if it is the first one available, even though the change will involve setting up a complete new set of tools.

The miscellaneous section planners are concerned only with the red, blue, and black schedules. All parts entering the miscellaneous section are started in the turning section, and it is the responsibility of the planner in that section to keep his green schedule sufficiently far ahead so that there is no delay in deliveries to the miscellaneous section.

The method of scheduling the parts is similar to that used in the turning section. Each day the planner reviews the parts in his section, and determines from the "travelers" the operation next to be performed on each part. If this occurs prior to plating, the red schedule shows by the length of its lines whether there is an adequate supply for two months' needs or whether there is a shortage necessitating immediate action on some particular part. If the operation is to be performed after plating, but before hardening, the blue schedule will establish the urgency, while if it occurs after hardening, the black schedule will show whether or not the parts are being delivered to the finished stores in time to meet the assembly requirements.

The planning for the line production section is operated in a somewhat different manner, the planners being interested in the colored schedules only to the extent that they control the movement of parts prior to their start down the machining lines. Once parts have been started in the production line, their movement is governed by the "Production Parts Schedule," Fig. 4. Each time a new department schedule is delivered, a production parts schedule is prepared for each part to be processed. In the two left-hand columns are listed the various lots to be machined and the date on which each should be started. In the right-hand columns are the dates on which each lot must be completed. Across the top of the sheet are listed the numbers of all key operations to be performed, spaced at intervals proportional to the time required to complete them. Normally, each space on the sheet is used to indicate one day; but where operations are short, two or more may be listed in one space. The spaces indicating plating and hardening are indicated by arrows to serve as check points.

Each day the planners take an inventory of all parts to be machined in the production lines, and enter the quantity of good parts completed under the number of the last operation performed. When a lot is finished, the total number of good pieces is entered in the "finish in-

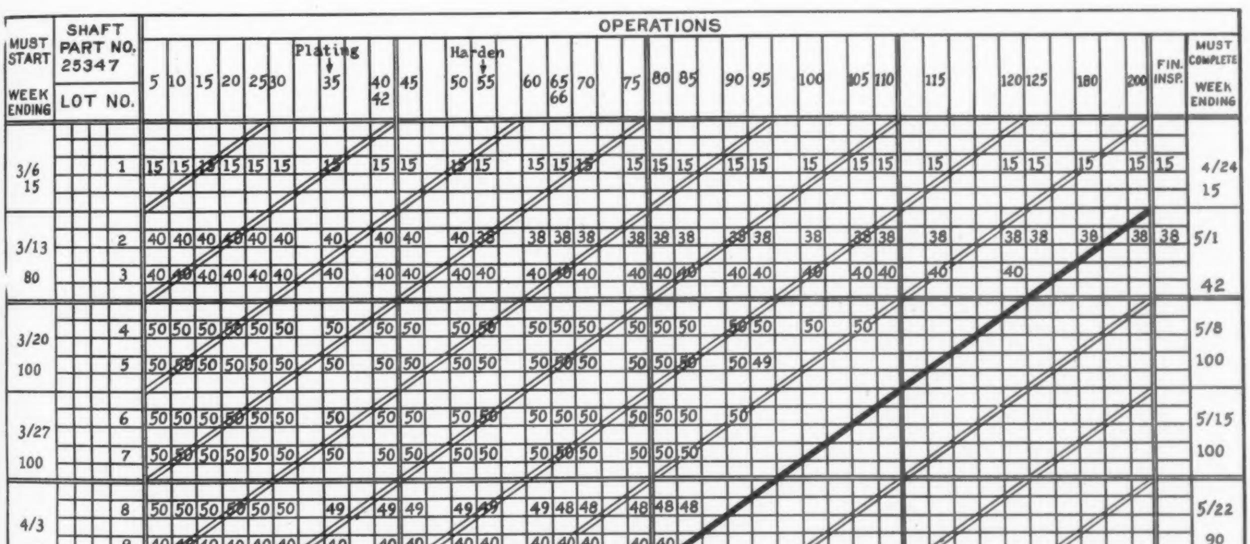


Fig. 4. Production Parts Schedule, Showing Progress of Work in the Production Line

PART NUMBER	Deliveries Against Schedule	QUANTITY OF PARTS IN SHOP					
		Order not Started	Orders Before Plating	Between Plating & Hardening	After Hardening	Total	3 Months' Requirements
73264	1/4 35	125	200	120	50	370	300
21246	1/4 20	50	80	30	10	120	250
50785	12/28 15	15	15	25	15	55	72

Fig. 5. Weekly Report to Chief Planner on Progress of Work in Process Compared with Three Months' Requirements

spection" column, and the amount in the "must complete" column is crossed off and the new balance entered.

At the end of each week, a red diagonal line starting in the last operation column is drawn backward to the left-hand side of the chart. This intersects the "must start" line at the current date and reaches the "lot" column just above the lot number that should then be starting in production. The planner can thus tell at a glance whether any particular lot is ahead of or behind schedule according to whether it is ahead of or behind the red line.

At the end of each week, the planners prepare a report (Fig. 5) for the use of the chief planner in the department. On this report, each part number is listed, and opposite it is the date of the week ending for which the requirements are being delivered to the finished stores and the amount of the requirements for that week that are yet to be filled. In succeeding columns are recorded the quantity in the assignment crib, but not yet started; the quantity in process, but not yet through plating; the quantity between plating and hardening; and the quantity hardened. In the seventh column is entered the total of columns four, five, and six, and in the final column the three months' requirements, as shown on the department schedule.

In using this report, the head planner is able to see whether a sufficient number of parts are in process to cover the three months' requirements, taking into consideration that if the parts are being delivered to finished stores ahead of schedule it is not necessary that a full three months' supply be in process. This latter fact may be determined by the date in the second column. If this is ahead of the current date, the conditions are satisfactory, but if behind, steps must be taken to speed up deliveries.

If the quantity in process is not sufficient, the head planner can tell from the "orders not started" column whether there is sufficient raw material in the store-room to fill his needs, or whether, because of a shortage, he should arrange a clear track ahead to permit doubling up in the immediate future. The fourth, fifth, and sixth columns indicate the distribution of the parts through the shop, and show up any bottlenecks.

This method of production control has been in use at the Wright Aeronautical plants for some time, and has been found to work very well. It is controlled by the planning division of the materials control department, which has the responsibility of seeing that, no matter what the obstacles, engines and spares leave the plant on or before the promised delivery date.

* * *

Limitless Debt Expansion

The political program for post-war reconstruction and prosperity which is advocated by a group of men of the highest political influence, and which is partially set forth in the report of the National Resources Planning Board recently submitted to Congress by the President with the suggestion that it be given careful consideration, would result in a limitless rise in public debt.

The theory behind these plans is that private investment will be insufficient after the war to absorb all of the nation's savings or to provide full employment. Therefore, the Government must become an investor on a large scale and must be a partner with industry in providing employment. It is maintained that the size of the public debt, if it is owed to the people of the United States, is not a matter of concern. All that matters is to keep the rate of interest low. It is argued that the reason why the "pump-priming" program of the Government during the depression, which required the borrowing of $28,000,000,000, failed to achieve its objective, was that it was not large enough.

The fallacy of the theory is that while such spending produces a flow of income while it lasts —largely into consumer goods industries—the interest charge remains forever and will have a deflationary effect, and the end result is to discourage private investment and to increase the cost of production. It should be kept in mind that the Government has no capital to be used for production and can obtain funds for working capital only by taking away capital from industry or from individuals by taxation or by borrowing.

The heavier the tax burden is, the fewer the private enterprises that can run at a profit, and the less incentive there will be to risk private capital. This would mean limiting the opportunities for private employment. Either real wages—living standards—would have to be lowered or the providing of employment would be increasingly thrown upon the Government.—*Stevenson, Jordan & Harrison, Inc.*

Refinishing Axles of Rolling Stock by Burnishing

By A. W. WHITEFORD,
Haynes Stellite Co.

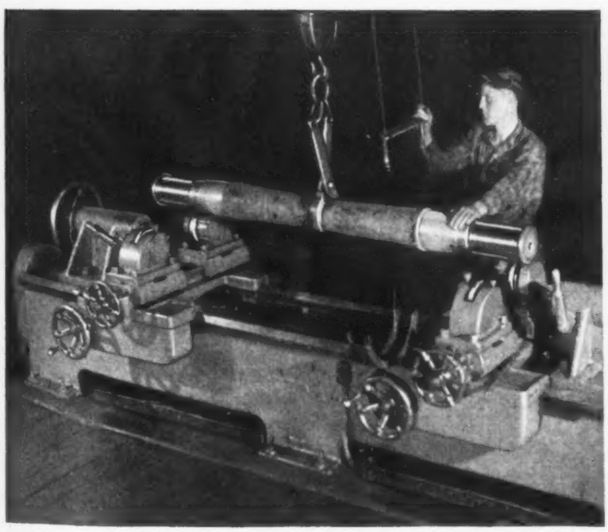
THE use of burnishing rolls for refinishing car-axle journals has been increased considerably in the effort to keep railroad rolling stock moving as efficiently as possible. Other parts on which this procedure is being effectively used are locomotive piston-rods, crankpins, air-pump rods; locomotive trailer, tank, and tender truck axle journals; engine truck and driving axle journals; motor truck axle journals with mounted wheels; locomotive driving axle journals with mounted wheels; and other parts. Unlike grinding, the burnishing operation involves no removal of metal from the surface being finished.

It is essential that the work be finish-machined to a smooth surface preparatory to burnishing. The burnishing operation is performed on a specially built burnishing machine or on a lathe having a reinforced tool-holder to support a special alloy burnishing roll. The work is usually run at approximately 150 surface feet per minute, and the burnishing roll is fed against one end of the surface to be burnished until it begins to revolve from the applied pressure. The roller is adjusted so that it bears against the work with the lightest pressure consistent with obtaining the desired finish, and the automatic feed is then engaged. When the roller has almost covered the full length of the part to be burnished, the automatic feed is disengaged and the job is completed by using the hand feed.

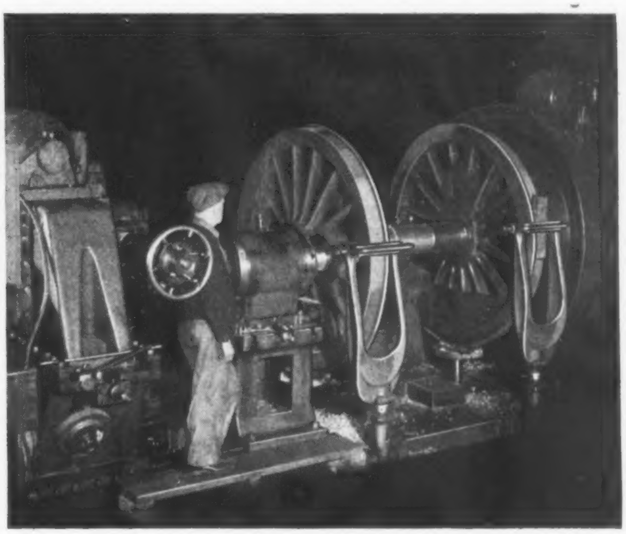
Finish-Turning Prepares Work for Burnishing

Probably the most common use of this process is for finishing new and worn car-axle journals. Special car-axle burnishing machines employ two sets of opposed rollers, two rollers being used to burnish each journal of the car axle simultaneously. In burnishing 5 1/2- to 7-inch diameter journals, 10 to 12 inches long, with A.A.R. Standard journal fillets at each end, the axle is run at approximately 150 surface feet per minute, with a roller feed of 5 1/2 inches per minute. Under these conditions, both journals can be burnished in about two minutes. Sometimes each journal is burnished twice to insure extra smoothness of the journal surfaces. In such cases, the over-all machine time is approximately seven minutes per axle.

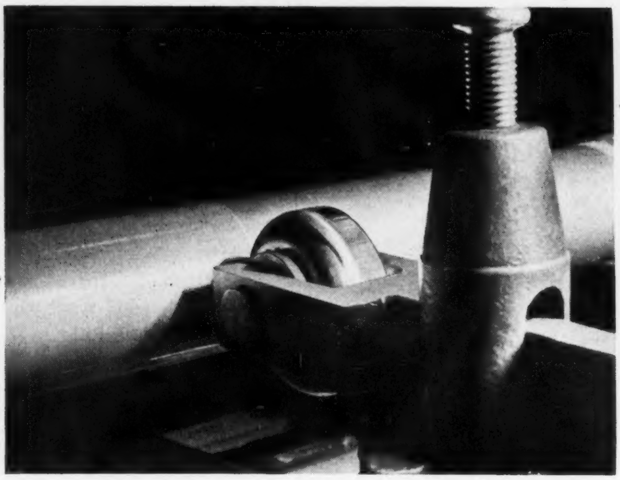
Similarly, a 4-inch diameter locomotive piston-rod, 48 inches long, can be completely burnished in fifteen minutes. One burnishing roller and a back-up steadyrest to prevent "springing" the rod are used at a surface speed of 150 feet



Burnishing the 100,000th Axle with Two Sets of Opposed Stellite Alloy Rollers in a Car-axle Burnishing Machine. In Eight Years' Service, These Four Rollers have Required No Maintenance other than Lubrication



Locomotive Tires are Turned, and the Main Axle Journals and All Crankpin Bearings are Turned and then Burnished with Stellite Alloy Rollers in the Machine Shown to Assure a Perfect Quartering Arrangement of the Pins



Finishing a 4-inch Diameter Locomotive Piston-rod by Burnishing. Note the Contrast in Smoothness in the Bearing Surface before (Right) and after (Left) Burnishing

Unmounted Locomotive Crankpins can be Burnished on Any Heavy-duty Lathe if a Special Tool-holder is Used to Hold the Stellite Alloy Roller, as Here Shown

per minute, or 145 R.P.M., with a feed of 3 1/16 inches per minute. Only one rolling is required.

In addition to production speed, a number of advantages are claimed for the burnishing method of finishing work. The burnished surface is work-hardened to a considerable degree, affording greater wear resistance and longer life in service. Some users have also found that this surface working of the metal by burnishing produces a marked increase in its fatigue strength. Furthermore, the surface finish obtained is a replica of the high polish on the roller surface, and fillets can be held within specified limits.

Rollers made of a special cobalt-chromium-tungsten alloy easily produce a fine bearing surface on the work. Stellite alloy burnishing rollers, supplied with Timken roller bearings, retain their high polish, resist wear, and minimize roller maintenance costs. Under magnification, the burnished surface shows a high degree of smoothness. In addition, because steel does not adhere to this alloy, which is essentially non-magnetic, the likelihood of steel particles clinging to the roller and marring the burnished surface is minimized.

Finishing 100,000 Axles with One Set of Rollers

The life expectancy of such special alloy rollers is illustrated by the experience of an eastern shop in which two sets of opposed rollers have burnished over 100,000 axles without any roller maintenance or repairs, except lubrication.

A western transcontinental railroad has had rollers in daily service for five years and no wear is yet evident in the rollers. As a result of the success with this type of burnishing rollers, a prominent eastern railroad recently acquired a battery of three car-axle burnishing machines, all equipped with these special alloy rollers and an automatic axle-removal carriage. Many other eastern shops have lately acquired not only car-axle machines equipped with this kind of roller, but have installed new locomotive driving wheel lathes with these rollers for the finishing of both main journals and crankpins. Such lathes permit locomotive axles with mounted wheels to be both turned and burnished.

* * *

Wheelbarrow Type Air Compressor

While designed originally for the armed forces, many post-war uses are expected for a compact wheelbarrow type of air compressor, built by the Quincy Compressor Co., Quincy, Ill. This unit can be wheeled around by one man, as it weighs only 225 pounds. Despite its small size, it comprises a single-stage air-cooled compressor with an air delivery of more than 16 cubic feet per minute at 80 pounds pressure per square inch. The compressor operates at the high speed of 1250 R.P.M. This type of air compressor is primarily used in locations inaccessible to stationary or truck-mounted units, and is built to withstand outdoor conditions.

* * *

The combined total cost to the nation, last year, of the legislative and judicial branches of the Federal Government was $38,000,000. The executive branch spent, even before the war, almost that much for publicity and promotion alone.—*Harry F. Byrd, United States Senator from Virginia*

How to Secure Fine Surfaces by Grinding

By the Late H. J. WILLS
and H. J. INGRAM, Engineer
The Carborundum Co., Niagara Falls, N. Y.

Tenth of a Series of Articles Describing the Factors that Govern Fine Surface Quality and the Means by which This Quality Can be Obtained—This Installment Deals with the Fundamentals of Lapping

LAPPING is commonly thought of as a method of attaining finer surface finishes and closer accuracy than can be secured by other methods. When it is necessary to get dimensional accuracy closer than a few ten-thousandths inch or surface quality better than 5 to 10 micro-inches r.m.s., most shop men assume that it is a job for honing or lapping. For the closest requirements, lapping is usually specified.

Yet, as was shown in the second article of this series (May, 1943, page 169), it is possible to grind with an ordinary grinding wheel to tolerances as close as 0.000005 inch for diameter and 0.00005 inch for roundness and straightness, and obtain a surface quality of from 0.4 to 0.7 micro-inch r.m.s. Many gage-makers get these results without lapping on plug gages; but they are not turning out such gages on a mass production basis.

On a production basis, it is possible to grind to a surface quality of from 2 to 5 micro-inches r.m.s., within a dimensional accuracy of 0.0001 to 0.0005 inch. For economical subsequent lapping, the latter limit should be secured by grinding. If such accuracy and finish can be secured by grinding, why resort to an additional operation? The answer is this:

First, as we have seen, such results require that the grinding machine be amply powered, maintained in the best possible condition, and located in a place where no vibration will be transmitted to it from other machines or the building. Very few machines are operated under such conditions to an extent that will permit them to do their best.

Second, even if the machine can do the job, higher production is often obtained by being satisfied with less than the best possible surface from the grinding operation, and securing it by subsequent lapping. If exactly the right degree of surface finish and dimensional accuracy is determined and secured by grinding, the total cost of the two operations is sometimes less than the cost would be if the desired results were obtained by grinding alone.

Lapping, then, may be resorted to for the purposes of securing minute accuracy of dimension, great surface smoothness, and correctness of shape. However, only slight degrees of out-of-roundness, taper, and out-of-parallelism can be corrected by lapping, for the process is not one adapted to heavy material removal. The most economical results will be obtained when not more than 0.0005 inch of material is to be removed. If tests show that there is considerable inaccuracy, and that the inaccuracies can be corrected faster by lapping than by more careful grinding, it is permissible to allow 0.001 inch for removal by lapping.

It should be remembered that a fine surface quality is a prerequisite of close dimensional tolerances. This is most strikingly shown when the part is to be subject to a sliding or rotating bearing contact, for although the tops of the "hills" of a less than perfect surface may measure almost exactly to size, they will wear down under friction, and the part will soon be under size. The finer the surface quality, the lower the hills will be and the less the wear before a stable bearing surface is developed.

List of Parts Frequently Lapped

Among the typical parts for both wartime and peacetime products which are commonly lapped are gears and worms, ball-bearing raceways, crankshaft pins and bearings, piston-pins for gasoline and Diesel engines, rollers for roller bearings, Sylphon seals, valve stems (especially those for airplane engines), plug and ring gages, thread chasers, carbide-tool cutting edges, plungers, fuel injection pumps and nozzles, gage-blocks, spacing washers and collars, the sides of ball-bearing rings, piston-rings, dies, molds, stop-cocks, carbide drawing dies, the inside of cylinders for various purposes, poppet valves and seats, railway slide valves, etc.

From this list, it is evident that the ultra-fine surfaces produced by lapping are used not only for bearing surfaces, but also where there must be a liquid or gas-tight seal either between two

planes or between a plunger or piston and its cylinder. Not only smoothness, but large bearing surface, is needed. For example, lapping is essential in poppet valves for high-pressure automobile and airplane engines and for some compressors to provide the close seal necessary.

Principles Involved in Lapping

Essentially, lapping consists of cutting down the ridges left by the preceding operation by means of abrasive grains, applied to the surface at low pressure and at comparatively low speed in such a way that the resulting "pattern" of scratches will be highly complicated. The low pressure and speed are primarily to prevent overheating, which might damage the surface and, by expanding the part, introduce dimensional inaccuracies. The complication of movement is to cut across the hills and valleys and to avoid the chance that any abrasive grain might get caught in the valleys and so deepen them. About the simplest pattern is that given by a combination of rotation and reciprocation secured by hand-lapping the outside or inside surfaces of cylindrical parts in a lathe, using any of the methods that will be described in a later article.

Until some forty years ago, all lapping was done by skilled workmen who held the work-piece in the hand, and (if flat) rubbed it across a stationary iron plate (the lap), which had been impregnated with fine abrasive grain. The workman was the sole judge of the pressure to be applied, the speed of the work across the lap, and the nature of the motion. About the simplest movement he used was a figure eight, with such variations and subsidiary movements as experience had shown him to be best for the type of work in hand. It took years to train a competent hand-lapper, and the method was slow and expensive, though highly effective in producing accurate pieces of high surface quality.

To increase production and permit lapping to be done by a less highly trained operator, several types of lapping machines have been developed. But even with these machines, the pressure and speed are largely dependent on the operator, although the nature of the movement is determined by the machine.

Pressures Used in Lapping

In deciding upon the pressure to be used, the operator must bear in mind that too great pressure may fracture the abrasive grains and score the work. This is especially likely to occur if a hard lap is used. With a soft lap, it is safe to use higher pressures.

The greater the pressure, the faster will be the operation as far as material removal is concerned; but the surface qualities will not be so good with high pressures as with lower ones. It is therefore necessary, in deciding upon the pressure to be used, to balance the qualities secured by lapping—speed of production against surface quality and accuracy.

Changes in the speed of the work relative to the lap have no appreciable effect as long as the speed is less than 800 feet per minute. Above 800, the finish improves as the speed increases, but, surprisingly, the speed with which material is removed is lowered by raising the work-lap speed ratio. Again, it is necessary to balance production rate against surface qualities.

Obviously, when the surface requirements are only moderate, it will pay to use high pressures and low speeds. If surface quality outweighs in importance the production rate, a low pressure and high speed should be used. No hard and fast table of pressures and speeds would be worth while, for too much depends on the peculiarities of the machine and the operator, the material being lapped, the type of abrasive used, and even the material of which the lap is made.

Materials for Laps and Selection of Abrasives

The earliest laps were made of some fairly soft material into which dry abrasive grains were rolled until they were firmly held by the lap, in much the way that the bond of a grinding wheel holds the grains.

Modern practice is to allow grain, suspended in some liquid vehicle, to roll between the work and the lap. The grain is not pressed into the lap. But here, too, it is essential that the lap be softer than the work, so that the grains can be held temporarily by the lap and so pass over the work with an abrasive action. The cutting is due to the fact that the grains move with respect to the work but not with respect to the lap.

The common lap materials used with abrasive grains in a "vehicle" are porous, open-grained cast iron; soft metals, such as lead or babbitt; whitewood; fiber; and even leather.

In general, using a harder lap will increase the finish and accuracy of the part by making a shallower cut, which gives less light reflection and consequently less luster. The speed of material removal will be reduced, but the wear on the lap will be increased. Specific recommendations for lap material will be given in later articles which will describe types of lapping work.

It is important to select the correct abrasive. As with grinding wheels, silicon carbide is used for faster cuts on the harder metals, aluminum oxide for the softer metals, and a special aluminum oxide for finish-lapping on the harder metals. Natural garnet is employed for certain special jobs, such as reduction gears and non-

ferrous valves. Sometimes it is necessary to use aluminum oxide or garnet to prevent the grains from becoming charged or impregnated in the softer metals.

The grit sizes used run from 60 to 1000, the latter a very fine powder employed chiefly for doing an extremely fine lapping job on soft materials.

Selection of Lapping "Vehicle"

The vehicles in which the grains are suspended may be water, alcohol, oil, soluble oil, or various greases and soaps. It is possible to give the general considerations governing the type of vehicle best suited, but only the experience of a lapping engineer or actual tests will give the exact vehicle best adapted for a specific job. If all other conditions—for example, work and lap materials—remain the same, the lighter vehicles, such as alcohol, will cut most rapidly, but will give the poorest surface qualities. The heavier vehicles, such as oils and greases, give progressively slower cuts but finer surface qualities.

Following are the characteristics to be taken into consideration in selecting a vehicle:

1. Maximum cutting speed without producing grain marks too deep for the surface requirements.
2. Cool cutting action.
3. Ability to hold the grain in suspension under any operating conditions.
4. Ability to hold the grains apart uniformly in all directions.
5. Only slightly affected by changes in temperature.
6. No bad effect on the operator's skin.
7. Non-corrosive.
8. Must not require an explosive substance for cleaning it from the work-pieces.

It is possible to mix these lapping compounds in the shop, but it is better to buy them already prepared. Shop mixing is usually done by rule of thumb, and at best, can be based only on the more or less limited experience of the operator. There is also greater danger of the compound being contaminated than when the mixing is done under controllable conditions. Compounds bought ready mixed are closely controlled as to proportions of grain to vehicle, and the wider experience obtained from handling diverse jobs enables the laboratory to make and recommend just the right compound for each job.

In addition to those lapping operations that involve loose abrasive compound and soft laps, there is another method which makes use of bonded abrasive "lapping wheels." While this is not, strictly speaking, a lapping operation, it gives comparable results. This method will be described in a following number of MACHINERY.

Getting More Suggestions from Shop Workers

By WILLIAM HENRY MORRISON

If there ever was a time when suggestions made by workers in the shop could be used, now is that time. However, the usual plan of having the men turn in suggestions signed by themselves does not always work out. The men seem to hesitate to turn in suggestions that way.

The E F G Engineering Works, Inc., Pueblo, Colo., felt that every suggestion that the management could get from the men actually doing the work in the shop would be worth while. Various schemes, however, failed to draw more than three to five suggestions a month.

Then a new approach was tried out. Blanks on which the workmen could write down their suggestions were printed in the form of pads. Each sheet had a perforated stub, and both the stub and the blank carried an identical number. Then all the worker had to do was to write his suggestion on the sheet, tear it off from the stub, and keep the latter as his record in case the suggestion was accepted. The blank with the suggestion was turned in to the management.

The very first week that this new form of suggestion blank was put into use, fifty suggestions were received, many of them very good. This represented one suggestion from every two workers, or an average of one suggestion each from 50 per cent of the men in the shop. This rate of suggestions has been kept up ever since.

* * *

Text-Books on Aircraft Production

Twenty-six text-books on aircraft production sponsored by the Bureau of Aeronautics, Navy Department, Washington 25, D. C., and published by the International Textbook Co., are now available. Additional text-books will be published from time to time. These books, which vary from thirty-two to seventy-five pages, 5 by 7 1/2 inches, are available to navy contractors in any quantity at a cost of 5 cents per copy. Orders should be sent directly to the International Textbook Co., Scranton, Pa., from whom a complete list of titles can be obtained.

* * *

Government bureaus have peculiar ideas about profits. They figure profits before taxes have been paid. There can be no profits until after taxes have been deducted. In most cases, after taxes are paid, there is only a very small percentage of profit left. To consider that part paid over to the Government in taxes as a company's profit is not common sense.

New Trade Literature

RECENT PUBLICATIONS ON MACHINE SHOP EQUIPMENT, UNIT PARTS, AND MATERIALS

To Obtain Copies, Fill in on Form at Bottom of Page 215 the Identifying Number at End of Descriptive Paragraph, or Write Directly to Manufacturer, Mentioning Catalogue Described in the March Number of MACHINERY

Non-Ferrous Metal- and Wood-Working Machines

ONSRUD MACHINE WORKS, INC., 3900 Palmer St., Chicago 47, Ill. Catalogue on non-ferrous metal- and wood-working machines, covering contour milling machines, electric routers, radial arm drills and routers, shapers, lathes, cutter grinders, and other tools. 1

Stellite Tools

HAYNES STELLITE CO., 30 E. 42nd St., New York City. Booklet entitled "Operating Information on Stellite 98M2 Cobalt-Chromium-Tungsten Alloy Turning and Boring Tools and Milling Cutters," giving cutting angles, cutting speeds, and chip-breaker and grinding-wheel data. 2

Ball Bearings for Replacement

NEW DEPARTURE DIVISION OF GENERAL MOTORS, Bristol, Conn. Booklet R, entitled "Interchangeable Ball Bearings for Replacement," containing numerically arranged lists of ten competitive makes of ball bearings, together with corresponding New Departure numbers. 3

Milling, Grinding, Broaching, and Lapping Machines

CINCINNATI MILLING & GRINDING MACHINES, INC., Cincinnati 9, Ohio. General catalogue M-995-2, covering the company's lines of milling machines, broaching machines, grinding machines, lapping machines, and cutter and tool grinders. 4

Cleaning for Painting

OAKITE PRODUCTS, INC., 26 Thames St., New York 6, N. Y. Service Report entitled "Cleaning and Surface Treatment of Ferrous Metals with Oakite Compound No. 86 preparatory to Painting or Applying Other Organic Finishes." 5

Precision Measuring Tools

VAN KEUREN CO., 178 Waltham St., Watertown 72, Mass. Catalogue and handbook No. 32 of 144 pages, 55 of which are devoted to precision measuring tools, and 89 to engineering formulas, tables, and data. 6

Magnetic Chucks

CONTINENTAL MACHINES, INC., 1312 S. Washington Ave., Minneapolis 4, Minn. Bulletin describing a new DoAll electromagnetic chuck and the Selectron, a current rectifying, demagnetizing, and power varying unit. 7

Powdered Metallic Friction Materials

GENERAL METALS POWDER CO., 130 Elinor Ave., Akron, Ohio. Catalogue entitled "Controlled Friction," containing information on powdered copper and Gempco powdered metallic friction material. 8

Radial Drilling Machines

AMERICAN TOOL WORKS CO., Cincinnati, Ohio. Bulletin 315, illustrating and describing the "American Hole Wizard"; Bulletin 458, on the use of the radial drill as a boring machine. 9

Measuring Instruments

METRICAL LABORATORIES, INC., 417 Detroit St., Ann Arbor, Mich. Bulletin covering indicating plugs and gages; also bulletin entitled "The Metricator," a device used for precision measurements. 10

Gear-Hobbing Machines

TRIPLEX MACHINE TOOL CORPORATION, 125 Barclay St., New York 7, N. Y. Catalogue on the Hamilton Swiss type precision gear-hobbing machines for small, accurate spur and spiral gears. 11

Chain Drive Data

LINK-BELT CO., 307 N. Michigan Ave., Chicago, Ill. Book 1991, containing tables giving chain drive centers and chain lengths for different sizes of cut-tooth sprockets. 12

Hydraulic Control Valves

R. D. WOOD CO., 400 Chestnut St., Philadelphia 5, Pa. 38-page catalogue on high-pressure hydraulic control valves. Includes engineering data and suggestions on the care of these valves. 13

Fastening Means

EATON MFG. CO., Reliance Division, Massillon, Ohio. Folder 101, entitled "Eaton Springtite Sembly," giving complete information about this fastening unit—a preassembled lock-washer. 14

Low-Temperature Welding

EUTECTIC WELDING ALLOYS CO., 40 Worth St., New York 13, N. Y. Catalogue on eutectic low-temperature welding, containing hints on how to increase welding efficiency on all metals. 15

Brazing Alloys in Gun Production

HANDY & HARMAN, 82 Fulton St., New York 7, N. Y. Latest issue of *Low Temperature Brazing News*, covering the use of Easy-Flo brazing alloy in gun production. 16

Heat-Treating Equipment

LEEDS & NORTHRUP Co., 4921 Stenton Ave., Philadelphia 44, Pa. Catalogue T-621, on the Vapocarb-Hump method of heat-treating steel. 17

Gages

REPUBLIC GAGE Co., 2228 Fenkell Ave., Detroit 21, Mich. Catalogue 1163, covering this company's line of cylindrical and thread gages. Engineering data is included. 18

Stock Blanks for Thread Milling Cutters

DETROIT TAP & TOOL Co., 8432 Butler Ave., Detroit 11, Mich. Bulletin CB-43, listing over fifty Detroit standard blanks for thread milling cutters. 19

Reclaiming Iron Castings by Welding

C. E. PHILLIPS & Co., 2750 Poplar St., Detroit 8, Mich. Booklet entitled "Four Ways to Salvage, Reclaim, and Conserve Iron Castings by Electric Arc Welding." 20

Lift-Trucks

WILLAMETTE HYSTER Co., 2902 N.E. Clackamas St., Portland 8, Ore. Bulletin illustrating and describing the Hyster 20 lift-truck, of 2000 pounds capacity. 21

Pumps

PIONEER PUMP & MFG. Co., 19679 John R St., Detroit 3, Mich. "Pump Engineering Manual," an 85-page reference book for machine tool builders and pump users. 22

Automatic Chucking Machines

NATIONAL ACME Co., 170 E. 131st St., Cleveland 8, Ohio. Bulletin CM-43, on Acme-Gridley Model RPA four-, six-, and eight-spindle chucking machines. 23

Electronic Control

GENERAL ELECTRIC Co., Schenectady, N. Y. Bulletin GEA-4126, describing the fundamentals and various applications of electronic control. 24

Coolant Pumps

RUTHMAN MACHINERY Co., 1823A Reading Road, Cincinnati 2, Ohio. 60-page catalogue on Gusher coolant pumps, describing each of the many types produced by this company. 25

Duplicating and Forming Parts

O'NEIL-IRWIN MFG. Co., 332 Eighth Ave. S., Minneapolis 15, Minn. Catalogue 44-6, entitled "The Di-Acro System of Metal Duplicating without Dies." 26

Powder Metallurgy

KEYSTONE CARBON Co., INC., St. Marys, Pa. 32-page booklet entitled "Powder Metallurgy," covering the advantages and describing the latest applications of powdered-metal parts. 27

Chain Drives

MORSE CHAIN Co., Ithaca, N. Y. Bulletin 43—a comprehensive 80-page catalogue on silent chain drives, including a great deal of engineering data. 28

Industrial Wire Cloth

C. O. JELLIFF MFG. CORPORATION, Southport, Conn. Catalogue containing engineering data and price list covering wire cloth, including tables of standard weights. 29

Welding Cranes

WHITING CORPORATION, Harvey, Ill. Bulletin on Whiting automatic welding cranes for facilitating the handling of large welding jobs. 30

Band Filing Machines

CONTINENTAL MACHINES, INC., 1312 S. Washington Ave., Minneapolis 4, Minn. Circular B101, illustrating and describing DoAll band filing machines. 31

Metal-Washing Machines

AMERICAN FOUNDRY EQUIPMENT Co., 555 S. Byrkit St., Mishawaka, Ind. Bulletin 9, describing the American "Tumbl-Spray" metal-washing machine. 32

Materials Handling

INDUSTRIAL TRUCK STATISTICAL ASSOCIATION, 208 S. La Salle St., Chicago 4, Ill. Sixteen-page bulletin entitled "Unit Loads—Their Handling, Shipment, Storage." 33

To Obtain Copies of New Trade Literature

listed on pages 214-216 (without charge or obligation), fill in below the publications wanted, using the identifying number at the end of each descriptive paragraph; detach and mail to:

MACHINERY, 148 Lafayette St., New York 13, N. Y.

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[This service is for those in charge of shop and engineering work in manufacturing plants.]

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City.. *State*..

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Tapping and Threading Machines

WARNER & SWASEY Co., 5701 Carnegie Ave., Cleveland 3, Ohio. Folder on precision tapping and threading machines. 34

Hardening and Tempering Baths

A. F. HOLDEN Co., New Haven 8, Conn. Bulletin 110, on Holden neutral baths for hardening and tempering. 35

Forgings, Shafting, and Crankshafts

STRUTHERS WELLS CORPORATION, Titusville, Pa. Bulletin on forgings, shafting, crankshafts, and similar forged products. 36

Tool Steels

DARWIN & MILNER, INC., 1260 W. 4th St., Cleveland 13, Ohio. Catalogue covering alloy tool steels, high-speed steels, and carbon tool steels. 37

Carbide Tools

TUNGSTEN CARBIDE TOOL Co., 2661 Joy Road, Detroit 6, Mich. Bulletin 44-1, on single-point, diamond-ground carbide tools. 38

Gears and Speed Reducers

D. O. JAMES MFG. Co., 1140 W. Monroe St., Chicago, Ill. Bulletin covering gears and speed reducers made by the company. 39

Punching Sheet Metal

WALES - STRIPPIT CORPORATION, 345 Payne Ave., North Tonawanda, N. Y. Circular PS, on plate set system for punching sheet metal. 40

Tapping Machines

L. J. KAUFMAN MFG. Co., Manitowoc, Wis. Bulletin 828, on Kaufman "Hi-Duty" tapping machines. 41

Carbon Seal Rings

PURE CARBON Co., INC., St. Marys, Pa. Booklet on carbon seal rings and their application to bellows type shaft seals. 42

Electrical Equipment

P. R. MALLORY & Co., INC., 3029 E. Washington St., Indianapolis 6, Ind. 1944 catalogue of radio, electrical, and electronic parts. 43

Forgings

STEEL IMPROVEMENT & FORGING Co., Cleveland, Ohio. Reference data book entitled "The Improvement of Metals by Forging." 44

Aircraft Motors

EMERSON ELECTRIC MFG. Co., 1824 Washington Ave., St. Louis 3, Mo. Catalogue descriptive of Emerson electric aircraft motors. 45

Dust Collectors

EDWARD BLAKE Co., 634 Commonwealth Ave., Newton Centre 59, Mass. Bulletin 443, on the Filtaire portable dust collector. 46

Magnetic Chucks

O. S. WALKER Co., INC., Worcester, Mass. Circular illustrating and describing a new permanent magnetic chuck. 47

Electric Motors

ELECTRIC MACHINERY MFG. Co., Minneapolis 13, Minn. Publication No. 173, on heavy-duty synchronous motors. 48

Factory Trucks

ROSE MFG. Co., 12400 Strathmoor, Detroit 27, Mich. Bulletin on heavy-duty wagon type factory trucks and trailers. 49

Free Machining Steel

W. J. HOLLIDAY & Co., Hammond, Ind. Catalogue 1243, on Speed Case and Speed Treat free machining steels. 50

Milling Machine Vises

BELLOWS Co., 861 E. Tallmadge Ave., Akron, Ohio. Bulletin CVH-60, on automatic milling machine vises. 51

Belt Sheaves

ALLIS-CHALMERS MFG. Co., Milwaukee 1, Wis. Bulletin B6310, on Texrope "Magic-Grip" sheaves. 52

Plastics

RICHARDSON Co., Melrose Park, Ill. Booklet covering all types of plastics and their use. 53

To Obtain Additional Information on Shop Equipment

Which of the new or improved equipment described on pages 218-246 is likely to prove advantageous in your shop? To obtain additional information or catalogues about such equipment, fill in below the identifying number found at the end of each description—or write directly to the manufacturer, mentioning machine as described in March, 1944, MACHINERY.

No.	No.	No.	No.	No.	No.	No.	No.	No.	No.

Fill in your name and address on other side of this blank.

To Obtain Additional Information on Materials of Industry

To obtain additional information about any of the materials described on page 217, fill in below the identifying number found at the end of each description—or write directly to the manufacturer, mentioning name of material as described in March, 1944, MACHINERY.

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Fill in your name and address on other side of this blank.

Detach and mail to MACHINERY, 148 Lafayette St., New York 13, N. Y.

[SEE OTHER SIDE]

Materials of Industry

THE PROPERTIES AND NEW APPLICATIONS OF MATERIALS USED IN THE MECHANICAL INDUSTRIES

Compound for Use in Balancing Motor Armatures

A material for use in balancing electric motor armatures, known as R-943 balancing compound, has been developed by the Sterling Varnish Co., 147 Ohio River Blvd., Haysville (Pittsburgh), Pa. This compound is furnished in a paste or soft putty form and is applied easily with the hands or with a knife. It sets at room temperature in about two hours to such a condition that it will not be affected by subsequent application of insulating varnishes. However, it does not attain its maximum hardness or mechanical strength unless subjected to a temperature of about 135 degrees C. 201

Compound that Prevents Rust and Improves Adhesion of Finishes

An acid type, two-function detergent, known as Oakite Compound No. 86, has been developed by Oakite Products Inc., 26 Thames St., New York City, for preventing rust on steel and for securing improved adhesion of such organic finishes as paint, lacquer, etc. This new product can be used for removing light spinning compounds, drawing lubricants, machining oils, finger marks, and shop dirt from steel parts.

In addition to eliminating the need for a preliminary alkaline degreasing, which is often required in preparing steel for organic finishing, it "conditions" the work by imparting a microscopic crystalline coating to the work surfaces. This coating performs the dual function of providing the basis for a firm bonding of the paint or lacquer coat and for resisting any rusting action between production operations. Heretofore restricted to war plants, Oakite Compound No. 86 has now been released for use in all metal-working plants..202

Emeloid Plastics with Wide Range of Hardness and Toughness

A new plastic known as "Emeloid" has been developed by the Emeloid Co., 287 Laurel Ave., Arlington, N. J. This plastic is so made that the hardness, elasticity, and toughness can be varied as desired in the different grades. It can be obtained in clear form or in various colors. The new plastic can be formed, molded, shaped, cut, sheared, sawed, punched, pierced, stamped, polished, drilled, machined, lithographed, and printed. 203

Cement that Replaces Putty for Glass Instrument Windows

Glass instrument windows have long been puttied in. This is a laborious hand operation, and much time is consumed in removing the putty smears. After extensive research, Westinghouse chemists have found a synthetic cement that seals the glass to the plastic instrument case far tighter than putty.

A simple, automatic machine applies a narrow band of the cement, and the glass is pressed into place. The cement sets quickly in a low-temperature oven, and cleaning of the glass is no longer necessary. 204

Transparent Plastic Model of a Crane Hook Photographed by Means of Polarized Light, which Vibrates in a Single Plane instead of Scattering like Ordinary Light. Refracted by the Stress Lines in the Model, the Light Produces Interference Bands Showing the Points where the Greatest Load is Borne by the Hook. When Photographed in Ordinary Light, No Lines Appear in the Model. Recently, Westinghouse Engineers Developed a New Plastic for This Purpose that can be Produced Cheaply in Large Quantities

To obtain additional information on materials described on this page, see lower part of page 216.

Shop Equipment News

Machine Tools, Unit Mechanisms, Machine Parts, and Material-Handling Appliances Recently Placed on the Market

Sundstrand Propeller Barrel Milling Machine

The Sundstrand Machine Tool Co., 2530 Eleventh St., Rockford, Ill., has recently built a special milling machine designed to form-mill the radii and angular surfaces on the inside of aircraft propeller barrels. The part milled by this machine is of tough steel and requires a heavy cut on practically the entire inside edge and bottom. An angular milling cutter with a radius at the bottom, using high-speed steel blades, is mounted directly on the spindle, which is driven by a 10-H.P. motor. The drive to the spindle is through V-belts with pick-off gears that provide for spindle speed changes in the ratio of 30 to 1.

The column is of heavy ribbed construction, and, in addition to carrying the vertical way surface for vertical travel of the spindle head, it can be fed and traversed to and from the work. The work itself is held in a special fixture mounted on a rotary table 22 inches in diameter. This table is constructed to provide sufficient rigidity to permit taking heavy milling cuts. The automatic cycle provides three independent motions of cross-feed to the column, vertical feed to the head, and rotary feed to the table, which are all timed and interlocked with the starting and stopping of the spindle and the flow of coolant.

Although designed for the specific operation described, similar machines can be built for a variety of profile-milling operations. The only changes necessary for such work would be in the fixture design and the application of the cam-roller unit to the head carrier. The machine has sufficient rigidity to accommodate a 15-H.P. spindle-driving motor. Each moving member of the machine is hydraulically actuated, the rotary table being driven by a Sundstrand fluid type motor. The rate of rotation can be varied from 1/2 inch to 10.1 inches per minute. 61

Special Machine Built by the Sundstrand Machine Tool Co. for Form-milling Propeller Barrels

General Electric Control for Welding Machines

A new current-regulating compensator for resistance welding machines has been developed by the Electronic Control Section of the General Electric Co., Schenectady, N. Y. The new compensator is specifically designed to facilitate consistent welding by holding the true heating value of the welding current constant for any heat-control setting without requiring continual manual adjustment.

After the predetermined heat-control setting for a particular job has been made on the compensator, it requires no further adjustment. It will hold the welding current within plus or minus 2 per cent under the same conditions that would cause the unregulated welding current to vary as much as plus or minus 20 per cent. This compensator can be applied to most General Electric resistance welding controls in which the phase-shift method of heat control is used. ...62

To obtain additional information on equipment described on this page, see lower part of page 216.


CORRECTLY SHARPENED
CUTTING TOOLS
LAST LONGER
Tools are Weapons
TREAT 'EM RIGHT!
Extend The Life Of YOUR Cutting Tools By Sharpening Them CORRECTLY On the No. 10 Cutter and Tool Grinding Machine.
By sharpening your cutters and tools on a machine built for the job you will increase production — will stretch your tool dollars — and of great importance now, will conserve precious high speed steel.
The No. 10 is built for the job to give the best sharpening results—designed by us after years of experience in making and using all types of cutters.
BROWN & SHARPE
PROMPT DELIVERY ON No. 10 enables you to install the machine now — so as to get immediate advantage of its usefulness.
We are proud to be honored with the Navy "E", awarded for outstanding accomplishment in Defense production.
Brown & Sharpe Mfg. Co. Providence, R. I., U. S. A.
BS
BROWN & SHARPE

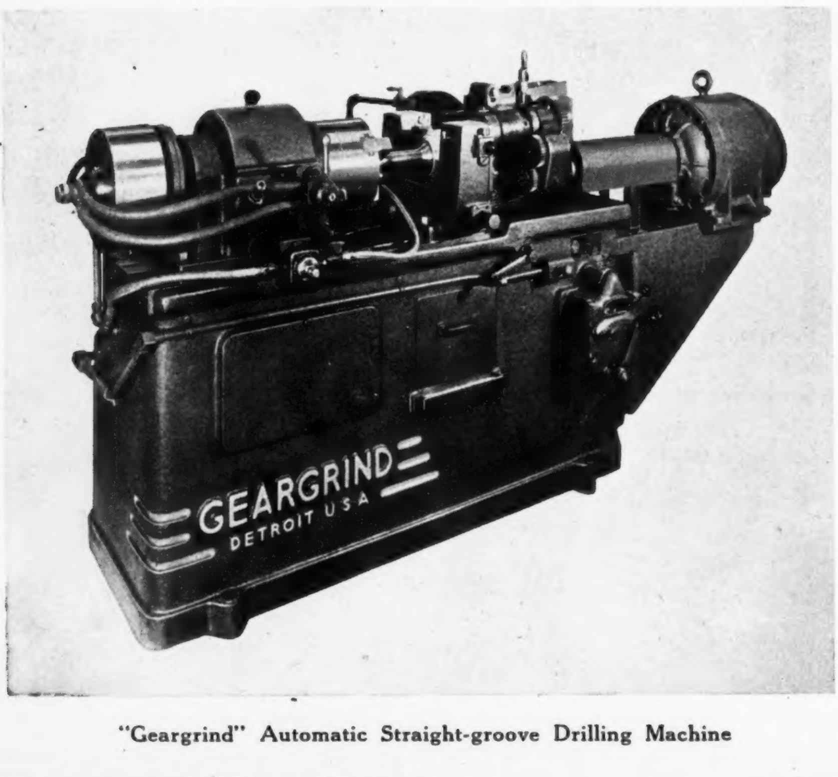
"Geargrind" Straight-Groove Drilling Machine

A straight-groove drilling machine designed for automatic operation is being placed on the market in two sizes by the Gear Grinding Machine Co., 3939 Christopher St., Detroit, Mich. These machines are now being used for cutting internal grooves in the outer races of Rzeppa universal joints, but can be adapted for other kinds of work. After the machines are loaded and started, they index and take the required cuts automatically. When the last cut is finished, the machines stop automatically, thus enabling one operator to run more than one machine.

These machines have hydraulic drives with variable-speed control for drill traverse and indexing. Change-gears for drill rotation have hardened and ground teeth. The machine designated GDS-1 has an 8-inch air-operated three-jaw chuck. The GDS-2 machine (shown in the illustration) has a 10-inch air-operated three-jaw chuck and an automatic hydraulically actuated three-pad equalizing steadyrest.

The GDS-1 machine will handle work having a maximum outside diameter or sphere diameter of 5 1/4 inches, as compared to 7 3/4 inches for the GDS-2 machine. The two sizes of machines will take work up to 15 and 17 inches in length, respectively. The maximum drill diameters are 1 1/8 and 1 11/16 inches, and the maximum groove lengths 2 1/2 and 4 inches, respectively. The maximum angular setting between the groove and the work axis is 4 1/2 degrees for the GDS-1 machine, and 4 degrees for the GDS-2 machine. The maximum distance from the axis of the work to the groove bottom is 2 1/4 inches for the former machine and 3 3/8 inches for the latter, with minimum distances of 1 9/16 and 1 3/16 inches.

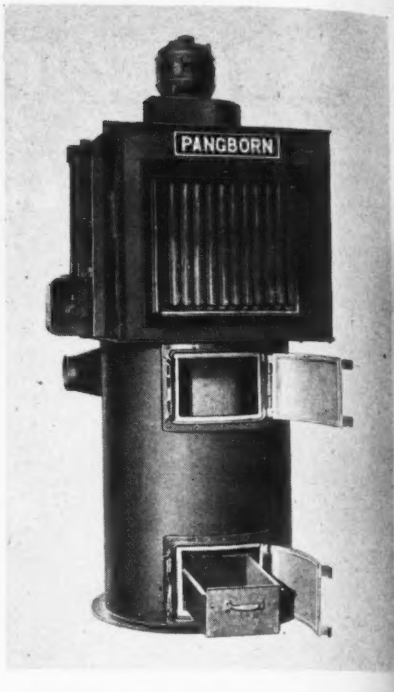
The GDS-1 machine is 54 inches high, 41 inches wide, and 96 inches long. It weighs 4000 pounds. The GDS-2 machine is 50 inches high, 48 inches wide, and 113 inches long. Its weight is also 4000 pounds. The hydraulic drives of these machines have 2- and 3-H.P. 1200-R.P.M. motors, respectively. Drill rotation is provided for by a 2-H.P. 900-R.P.M. motor, and the coolant pump is driven by a 1/4-H.P. 1750-R.P.M. motor. 63



"Geargrind" Automatic Straight-groove Drilling Machine

Pangborn Industrial Type Dust Collector

A dust collector designed to solve dust control problems where a self-contained unit of comparatively small size is desired has been brought out by the Pangborn Corporation, Hagerstown, Md. This new dust collector has the same construction and performance characteristics as the larger Pangborn installations. It is suitable for collecting the dust from grinding, buffing, and polishing machines.



Unit Type Dust Collector Brought out by the Pangborn Corporation

The unit consists of two major sections—a preliminary centrifugal section and a secondary cloth screen section. Dust-laden air enters the centrifugal section, where, due to a reduction in air velocity and centrifugal action, the bulk of the entrained material is separated from the air stream. The air containing only the finely divided dust particles then flows upward to the secondary cloth screen section, where the fine dust is effectively filtered out.

The clean air then passes to the exhauster and is discharged. The cloth-covered screen frames are provided with a shaking device, which is operated at intervals, while the exhauster is shut down, to free the cloth surfaces from the collected fine dust. This dust, together with that precipitated from the preliminary centrifugal section, is deposited in the common dust drawer or receptacle. The new collector, known as Type CK, is made in three sizes, of 1000, 2000, and 3000 cubic feet per minute capacities, operated by 3-, 5-, and 7 1/2-H.P. motors, respectively. 64

To obtain additional information on equipment described on this page, see lower part of page 216.


Shaft & Roll Straightening
...with a Cincinnati Press Brake!

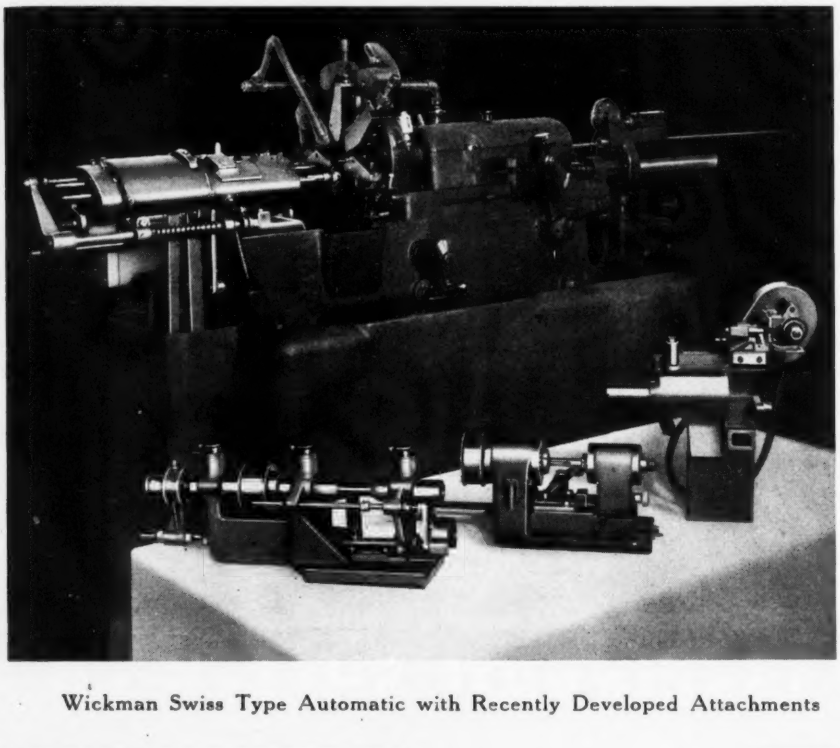
Attachments Developed for Wickman Swiss Type Automatic

The Wickman Corporation, 15533 Woodrow Wilson Ave., Detroit 3, Mich., has brought out five new attachments for the Wickman No. 2 Swiss type automatic to increase the range of work that can be handled on this machine. The attachments comprise a three-spindle arrangement for multiple operations, and separate attachments for high-speed drilling, threading, slotting, and taper-pin turning. The three-spindle attachment, shown mounted on the machine, can be used for centering, drilling, reaming, threading, or tapping. Indexing is controlled by two plate type cams, and the feeds are actuated by a sleeve type cam.

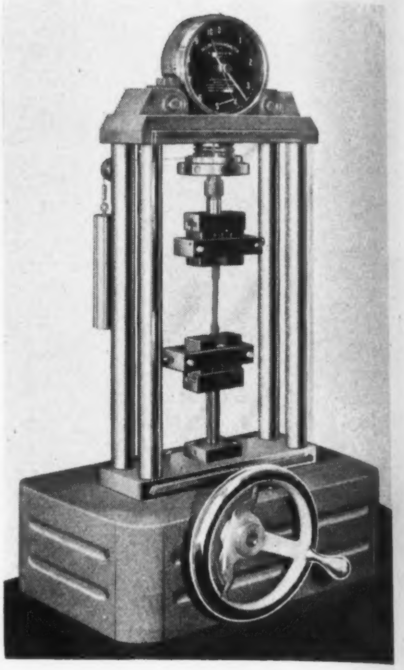
The No. 1 spindle is non-rotating and is used for centering and drilling, while the No. 2 spindle can be rotated in the opposite direction from the machine spindle rotation or can be held stationary for drilling and reaming operations. The No. 3 spindle may be allowed to over-run the machine spindle for precision threading, and it can also be held stationary for drilling or reaming. The three spindles can be employed in any order desired, one at a time.

The high-speed drilling attachment has a drum type cam feed and a spindle that rotates in a direction opposite that of the machine spindle. The threading attachment, shown at the left in the illustration, performs precision threading operations with self-opening die-heads having a fine finish, without reducing the speed of the machine spindle. Coolant is supplied to the die-head through the hollow spindle.

The slotting attachment, shown at the right, can be used for slotting or milling the end of any part produced, a pick-up arm grasping the part as it is being cut off and carrying it to the saw where it is slotted and then automatically ejected into the work tray. The pick-up arm is securely locked in position during the slotting operation. Movement of the pick-up arm is controlled by two cams. When using this attachment, the No. 3 tool-slide must be removed from the machine, but the attachment can be used simultaneously with any of the other attachments. Although a taper can be generated by the regular method, an attachment is provided for machining long, extremely accurate tapers with the No. 1 tool, using a form bar which is mounted on the headstock; thus the taper on the part is an accurate reproduction of that on the form bar. 65



Wickman Swiss Type Automatic with Recently Developed Attachments



Portable Tensile Testing Machine Built by W. C. Dillon & Co., Inc.

Dillon Portable Tensile Testing Machine

W. C. Dillon & Co., Inc., 5410 W. Harrison St., Chicago 44, Ill., has brought out an improved portable tensile testing machine developed to enable tensile, compression, transverse, or shearing tests to be made more easily and economically than with earlier models. Brazed joints, spot-welds, standard rounds or flats, cloth, hardware, porcelain, springs, Bakelite, and many other materials can be rapidly analyzed for relative strength on this tester.

The machine has seven interchangeable indicators, giving a range of tensile strength readings of from 0 to 250 pounds up to 0 to 10,000 pounds. The tester weighs 132 pounds, and is only 35 inches high. The serrated gripping jaws permit an exceptionally rapid insertion and removal of the specimen tested. This hand-driven machine can be readily motorized, and is available with a metal floor cabinet having specimen space and shelf for motorizing. 66

Anker-Holth High-Pressure Hydraulic Fittings

A line of high-pressure hydraulic fittings cut from solid steel bar stock and designed for 3000 pounds

To obtain additional information on equipment described on this page, see lower part of page 216.

SUPER SERVICE RADIAL DRILLS

SPEED...ACCURACY...CONVENIENCE—ON TOUGH DRILLING JOBS!

A "jumbo" job on a jumbo valve made of carbon molybdenum steel—and the Super Service Radial Drill does it with plentiful, smooth power and with the speed and accuracy made urgent by today's war needs. The machine is one of the battery of Super Service Radials in the plant of The Edward Valve and Manufacturing Co., Inc., of East Chicago, Ind. Work consists in drilling bolt holes on the bonnet flange of the body casting of a 14" valve for service at 1500 lb. pressure at 950°F. Note ruggedness of the machine—and low, convenient control levers that set a new standard for fast handling! Complete details sent upon request. The Cincinnati Bickford Tool Co., Oakley, Cincinnati 9, Ohio.

hydraulic working pressure has been brought out by the Anker-Holth Mfg. Co., 332 S. Michigan Ave., Chicago 4, Ill. The pipe connections are for 3/8 inch outside diameter seamless steel tubing with 0.050 inch wall thickness, and the soldered connections for 1/4-inch tubing. The high-pressure assemblies include a check-valve, which is reversible by placing the steel ball ahead of the spring; a safety valve, which is spring-loaded and adjustable; a straight connection; tee and elbow assemblies; and 3/8- and 1/2-inch four-way valves. ...67

Queen City "Super Twenty" Shaper

A 20-inch shaper known as the "Super Twenty," has been brought out by the Queen City Machine Tool Co., 240 E. Second St., Cincinnati 2, Ohio. This new shaper is adapted for heavy production, as well as general tool-room work. The ram is of the V type with wide bearings on both the bottom and sides. The main bull wheel gears and the back-gear train are of the helical type. The clutch is of the dry multiple-disk type.

Changes of feed are accomplished by simply turning a knob. The high-torque motor for the power rapid traverse is standard equipment. This motor is push-button controlled from the operating side of the machine, and can be operated even though the feed is engaged. In machining an irregular surface, it is not necessary to disengage the feed to employ the power rapid traverse. The table can be fed through a portion of the cut and then moved quickly by rapid traverse to the next surface for starting the cut by pressing the power rapid traverse button.

The top of the machine table is 16 by 14 inches, and the height of the side table is 15 inches. The table has a longitudinal travel of 23 inches, and can be adjusted to a maximum distance of 16 1/2 inches from the ram. The head has a vertical movement of 9 inches. The vise jaws are 11 by 2 1/2 inches, and have a maximum opening of 13 1/2 inches. The eight ram speeds range from 13 to 150 strokes a minute. The twenty table feeds range from 0.008 to 0.191 inch.

The machine is lubricated by a force-feed system. Limit switches serve to prevent over-run of the table either by power rapid traverse or power feed. Power is supplied by a 5-H.P., 1800-R.P.M. motor with a V-belt drive. A 3/4-H.P. motor provides rapid traverse. The machine weighs 4500 pounds. ...68

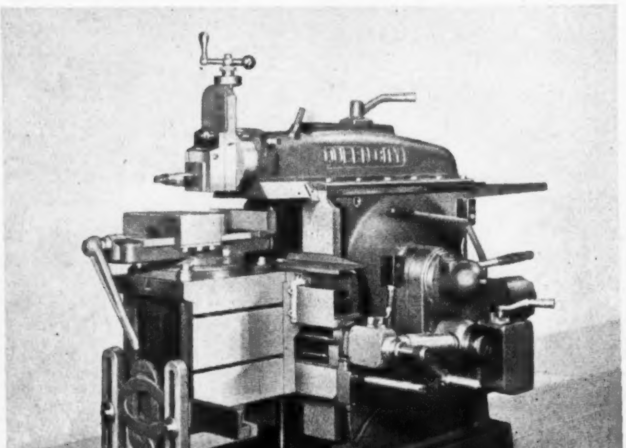
DoAll Mobile Inspection Unit

The need for constant checking of measuring instruments is a primary requisite to quality control. In the past, short shut-down periods were necessary in some plants to permit the inspection departments to check and correct all work-measuring instruments. The new DoAll mobile inspection unit brought out by Continental Machines, Inc., 1301 Washington Ave., S., Minneapolis 4, Minn., eliminates the necessity for such shut-downs.

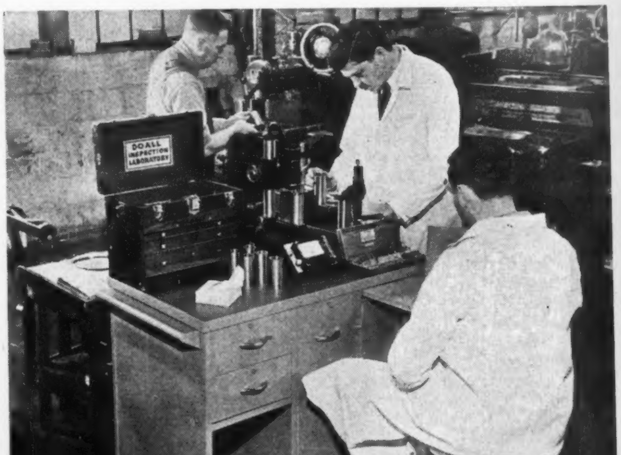
This unit, occupying an area of about 24 by 42 inches, contains complete precision inspection equipment. Light waves viewed through an optical flat produced by a monochromatic light provide the basic standard of measurement. A set of eighty-three gage-blocks, twenty different gaging instruments, and a comparator are provided.

The new DoAll comparator gage has four ranges of magnification with 6 1/2-inch height gaging capacity and a 4-inch throat capacity having variable spindle pressures of from 8 to 40 ounces. An illuminated magnifying glass on a stand is also provided.

The unit is mounted on four rubber-tired caster wheels which permit it to be easily moved about the plant. The wheels can be locked to hold the unit stationary. Storage space is available for all precision instruments and gages, and there is a desk drawer with ample space for records. ...69



"Super Twenty" Shaper Developed by the Queen City Machine Tool Co.



DoAll Mobile Inspection Unit for Checking Gages and Work

To obtain additional information on equipment described on this page, see lower part of page 216.

There's no substitute for EXPERIENCE!

Ex-Cell-O's wide experience in designing and building special machines to increase output and lower costs assures you practical advantages in your immediate or near future production

Increased production attained in precision machining of this aircraft crankcase on the above Ex-Cell-O special-purpose machine.

You have a substantial background of experience to draw from when you bring to Ex-Cell-O your problem in the *precision* machining of metal parts on a high production basis . . . whether it concerns an immediate war production job or a future product you are now planning. The more economical production of accurate metal parts necessitates single-purpose machines of improved efficiency, capable of giving greater output and reducing unit cost. For years Ex-Cell-O has been an acknowledged leader in the field of special-purpose machines . . . *precision* machines with exclusive features that represent the utmost in accuracy, production, operating ease, rigidity, and durability. This is why you should utilize Ex-Cell-O's experienced engineering and manufacturing facilities. Ex-Cell-O has representatives in all of the nation's principal manufacturing centers. Consult the one nearest you, or write to Ex-Cell-O Corporation Head Office in Detroit.

EX-CELL-O CORPORATION • DETROIT 6, MICH.

Precision THREAD GRINDING, BORING AND LAPPING MACHINES • TOOL GRINDERS • HYDRAULIC POWER UNITS • GRINDING SPINDLES • BROACHES • CONTINENTAL CUTTING TOOLS • DRILL JIG BUSHINGS • DIESEL FUEL INJECTION EQUIPMENT PURE-PAK CONTAINER MACHINES • R. R. PINS AND BUSHINGS • PRECISION PARTS

XLO

EX-CELL-O *for* PRECISION

Stanwood Oil-Bath Tempering and Drawing Furnace

A compact, heavy-duty, oil-bath furnace, designated Model 128, has been added to the line of heat-treating equipment made by the Stanwood Corporation, 4819 W. Cortland St., Chicago 39, Ill. This new gas-fired furnace is designed especially for the rapid and effective tempering or drawing of small parts to relieve stresses set up by quenching or to bring about a change in grain structure of the metal. The units are heated by immersion tubes to obtain maximum thermal efficiency and quick heating. The super-power gas burners made by this company and used in this furnace are completely enclosed, but are readily accessible through the door at the front.

Thermostatic control and an indicating regulator assure accurate temperatures. The units can be equipped with right- or left-hand drainboards, so pitched that the oil will flow back into the bath. Square or cylindrical baskets for holding parts to be tempered or drawn are available. Oil-bath furnaces of this type are available in a variety of sizes. The particular unit illustrated, built for an aircraft plant, is 24 inches wide, 34 inches front to back, 34 inches high, and has a tank 14 inches deep. 70

Stanwood Oil-bath Tempering and Drawing Furnace

Lincoln Engine-Driven Arc-Welder

A light weight, 200-ampere, "Shield-Arc" welder of rugged construction, with enclosed rubber-mounted engine of 29 H.P., is announced to the trade by the Lincoln Electric Co., Cleveland 1, Ohio. This new unit, supplied with base and canopy as shown in the illustration, has a current capacity range of 40 to 250 amperes. Dual control of the welding current is accomplished by adjustment of the series fields and the generator speed. The welder uses either bare or coated electrodes for metallic arc welding, and can also be used to supply uniform welding current for carbon arc welding.

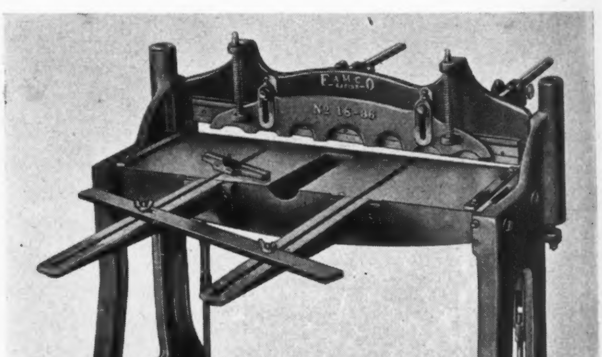
The generator control or "job selector" assures accuracy of open circuit voltage and permits precise control of the engine speed from 1500 to 1150 R.P.M. for welding. This control can be used to manually reduce the engine speed to as low as 750 R.P.M. when it is necessary to stop welding for a few minutes at frequent intervals. The unit weighs approximately 1130 pounds, has an over-all length of 65 1/4 inches, a width of 24 inches, and a height of 41 1/2 inches. 71

Famco Sheet-Metal Shears

The Famco Machine Co., 1300 Eighteenth St., Racine, Wis., recently started production on foot-operated sheet-metal squaring shears of compact design. This new machine is sturdily constructed of semi-steel, and is accurately machined. The cross-head is reinforced with a steel tie-rod to maintain proper knife alignment and assure accurate shearing. The compression springs are encased to eliminate breakage, and the knives have cutting edges capable of shearing up to 18-gage mild steel.

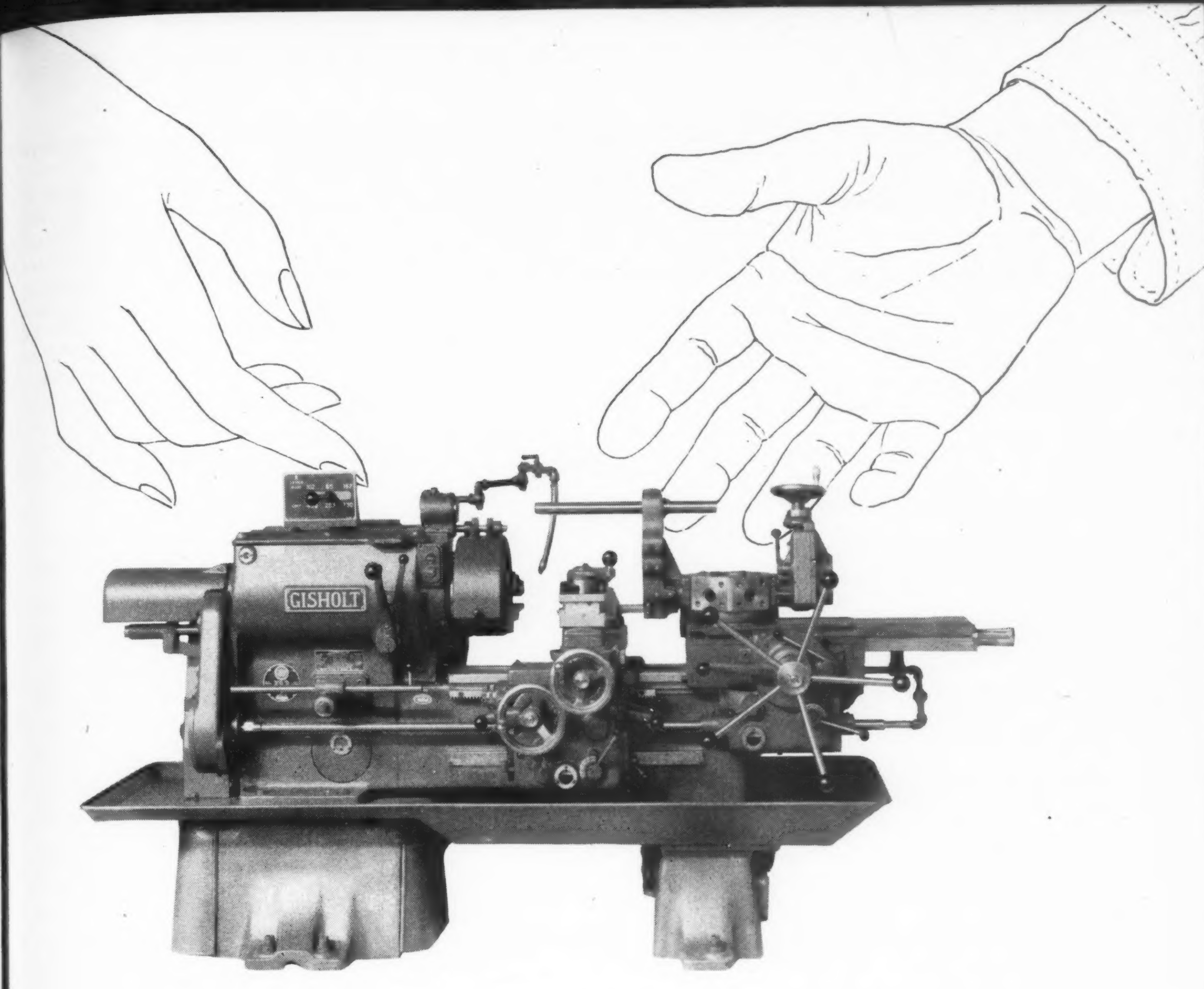
Fast, accurate depth setting is accomplished with back gages which are adjustable on heavy circuit rods by means of graduated racks and pinions. High cutting pressure with a minimum effort is obtained through the leverage arrangement of the foot-pedal. The shears are

Lincoln Engine-driven Arc-welding Machine



Famco Foot-operated Sheet-metal Shears

To obtain additional information on equipment described on this page, see lower part of page 216.



This Postwar Improvement Couldn't Wait

Hydraulic Clutching and Braking. With this new Gisholt improvement comes ease in starting, stopping and reversing the spindle. It puts an end to tugging at levers, to fatigue. The only physical effort required to engage clutches is a mere flick of the hand on the hydraulic control—to right or left. In neutral position, automatic spindle braking brings the work to a quick, smooth stop.

Why save an important improvement like this for postwar announcement? It's needed *now* to speed up war production. It's available *now,* as standard equipment, on all Gisholt Ram Type Turret Lathes. If you'd like more detailed information, write us.

GISHOLT MACHINE COMPANY
1209 *East Washington Avenue* • *Madison, Wisconsin*

GISHOLT

...Look Ahead...Keep Ahead...With Gisholt

RRET LATHES • AUTOMATIC LATHES • BALANCING MACHINES • SPECIAL MACHINES

available in five widths, of 22, 30, 36, 42, and 52 inches. The 36-, 42-, and 52-inch machines are furnished with a "hold-down" attachment for holding the stock in place while it is being cut. All models are equipped with front, back, and side gages. 72

Combination Hardening and Drawing Furnace

A combination unit designed to do a complete heat-treating job has been brought out by the Waltz Furnace Co., 2456 Gilbert Ave., Cincinnati 6, Ohio. This unit, known as Model CH, is made in the following three sizes: 8 inches wide by 6 inches high by 12 inches deep; 10 by 8 by 15 inches; and 12 by 10 by 18 inches.

The temperature in the hardening furnace is automatically controlled, correct heating being assured by means of an indicating pyrometer that can be set to hold any temperature between 1350 and 2300 degrees. Within the muffle or heating chamber, a protective atmosphere can be introduced and controlled by two valves and gages to prevent scaling of the work or the forming of a soft outer surface or skin. The gages make it possible to duplicate the protective atmosphere once the type needed has been determined. Operating efficiency is obtained by walls 7 inches thick, made of fiber-brick and block insulation material.

There are two quenching tanks in the center of the unit, the small one for oil and the larger one for water. The water entirely surrounds the oil tank. Perforated baskets are provided in both tanks. The recirculating drawing furnace has a range of 250 to 1100 degrees, which is controlled by an automatic indicating pyrometer similar to that on the hardening furnace. The interior of the drawing furnace is of alloy steel around which there is a cast insulating lining which, in turn, is protected by an outer shell of steel. Inside the furnace, hot air for tempering, which is heated by a unit in the base, is recirculated by a high-velocity alloy-steel fan, also located in the base. Foot-treadles are provided for opening the furnace doors. The complete small-size unit occupies a floor space 33 by 98 inches. 73

Resistance Welder Developed for Storage Battery Operation

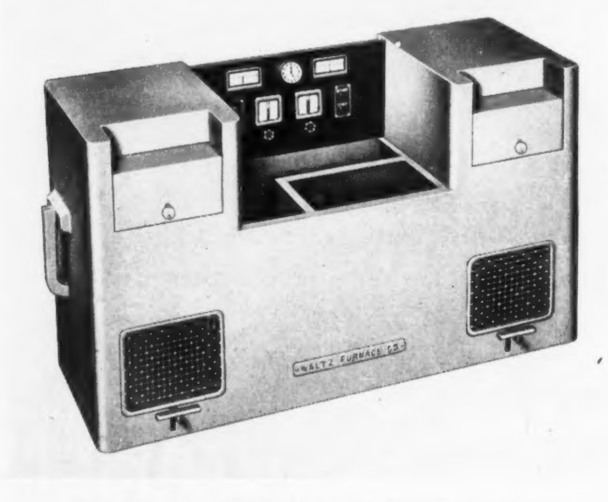
What is believed to be the first practical direct-current resistance welder using storage batteries as a source of welding current has been brought out by the Progressive Welder Co., 3050 E. Outer Drive, Detroit 12, Mich. This new equipment is now being used for aluminum welding on aircraft assembly work.

The use of batteries as a source of "stored energy" for resistance welding involves no radical redesign of available welding machines, since modified types of welding machines or guns made by this company can be used in combination with the storage battery power unit. This welder makes possible the application of resistance welding, even of aluminum, in localities where power supply limitations have previously prevented the use of other forms of stored-energy welders. The only requirements are sufficient power to operate a battery charger. It is claimed that the use of this battery power source represents a material reduction not only in the initial cost of the welding installation, but also in operating cost, particularly with respect to current consumption and maintenance cost.

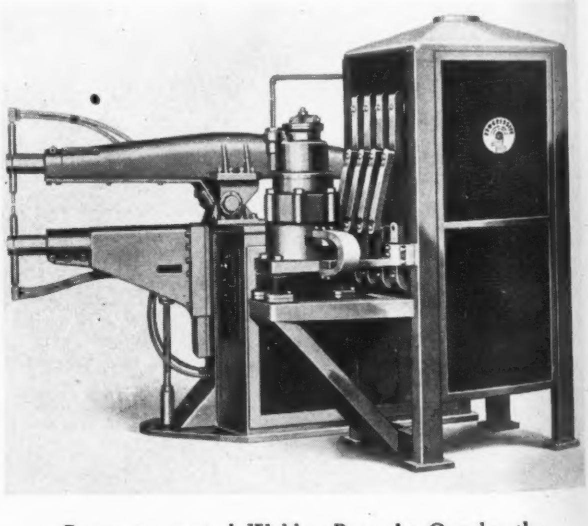
Two new developments—a battery design that will withstand high repeated discharge rates, and a contactor-controller which will control and interrupt large amounts of current without arcing—have made possible the design of this welder. Several types of welders of the rocker-arm, pedestal, and gun types are available for use with the storage battery unit. The welding procedure is similar to that employed with conventional equipment. 74

Wells "Suregrip" Electrode-Holder

The Martin Wells Co., 5886 Compton Ave., Los Angeles 1, Calif., has brought out a welding electrode-



Combination Hardening and Drawing Furnace Built by Waltz Furnace Co.



Battery-operated Welder Brought Out by the Progressive Welder Co.

To obtain additional information on equipment described on this page, see lower part of page 216.

holder known as the "Suregrip," which has been especially designed to reduce electrode costs. The welding rod is held securely in this holder by gripping only 5/8 inch of the bare end. It is claimed that the holder will not heat up even when the electrode is burned down to a stub only 1 inch in length.

Savings of from 7 to 14 per cent on electrode rods are claimed for the holder, the upkeep of which is said to average 65 cents per 100 days' operation. This low maintenance expense is due largely to the new reinforced insulator caps employed.

The holder has a fully insulated handle which remains cool and will not swell or shrink from exposure to moisture or heat. It grips the electrode with a pressure of 1000 pounds. 75

Tocco Junior Induction Heating Machine with Mobile Top Unit Placed on Bench for Brazing Carbide Tips to Tool Shanks

Tocco Induction Heating Machine

The Ohio Crankshaft Co., 3800 Harvard Ave., Cleveland 1, Ohio, has placed on the market a new low-cost 7 1/2-kilowatt output Tocco Junior induction heating machine with a work unit that can be separated from the power unit to facilitate shop operations. When used in this manner, it is connected to the power unit by a cable that need not be limited as to length.

This unit provides a wide range of induction heating for brazing, annealing, and heating for forming and for hardening small parts. It is especially designed for brazing carbide-tipped tools, and is particularly adapted for use in toolrooms. The unit can be used in various ways in the production line as a utility "heat-treating department." It is housed in a rigid welded steel cabinet and is equipped with a vertical type 220- to 440-volt three-phase sixty-cycle motor-generator set that provides 9600 cycles of high-frequency power.

The simple motor-generator set is designed to insure continuous operation at maintenance costs, and has been developed especially for use in the Junior Tocco machine. For surface hardening, the work unit is furnished with a quenching control valve, manifold, and gage. A stop-and-start push-button with signal light is located in the upper right-hand corner of the unit. Quenching water can be brought to the machine through an ordinary hose, and drainage can be taken care of by the same medium. 76

Bolt-Head Drilling Machine and Multiple Collet Fixture

The bolt-head drilling machine and the multiple collet work-holding fixture shown in Figs. 1 and 2, respectively, were brought out recently by Zagar Tool Inc., 23880 Lakeland Blvd., Cleveland 17, Ohio, to speed up war production work. The bolt-head drilling machine is designed to drill six wire-locking holes simultaneously in the head of a 5/8-inch, hexagonal, aluminum, aircraft-pump screw at an average production rate of 300 pieces per hour. The work is placed in the holder by hand. The simple turn of a lever causes the drilling slides to move inward and drill the six holes simultaneously, after which the lever is turned to release the work. This special drilling machine

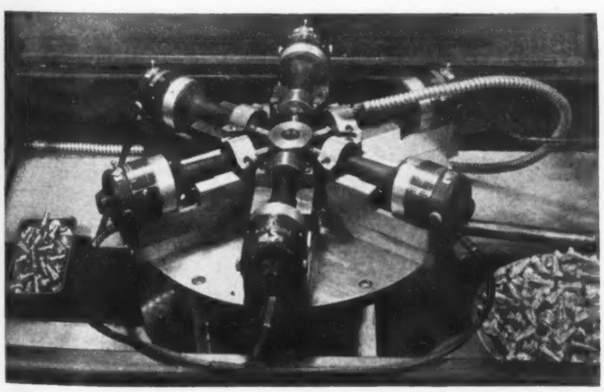


Fig. 1. Zagar Bolt-head Drilling Machine

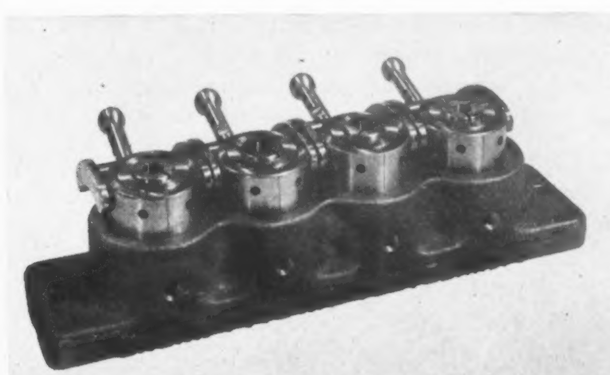


Fig. 2. Zagar Multiple Collet Fixture

To obtain additional information on equipment described on this page, see lower part of page 216.

Coast to Coast

GUIDE TO
AND PARTS

CEMENTED CARBIDES manufactured by Carboloy Company are available to you under this nationwide 3-way plan of distribution that provides maximum service and availability throughout the entire range of carbide use:—

1. *Through Distributors:* Authorized distributors in important metal-working areas carry stocks of Standard Carboloy Cemented Carbide Tools, Blanks, Dressers and Masonry Drills and offer complete technical service through factory-trained representatives.

2. *Through Tool Manufacturers:* Leading tool and parts manufacturers are authorized to supply their products, covering practically all types of special—often patented—tools, cutters and gages, as well as many miscellaneous parts—equipped with Carboloy Cemented Carbides.

3. *Direct Carboloy Service:* Direct service by Carboloy Company is provided by a large staff of experienced sales and service engineers operating throughout the country.

Put this comprehensive system of service and supply to work for your plant. Specify "Carboloy" for your cemented carbide requirements.

Look for the trademark* CARBOLOY (or the trademark) *on the tools you buy. It is

was mounted on a regular stock wash tank to save time and the expense of constructing a special stand.

The multiple collet holding fixture, Fig. 2, was brought out to meet the requests of users of standard single Zagar holding fixtures for equipment having a greater work-holding capacity for use on large milling machines. This multiple fixture makes possible numerous set-ups which materially increase the output and maintain a high degree of accuracy. It consists primarily of four Zagar holding fixtures in either the 1- or 2-inch size. These fixtures can be mounted either parallel with, or at right angles to, the spindle. Fixtures with two, three, or four collets, or multiples of these numbers can be furnished.

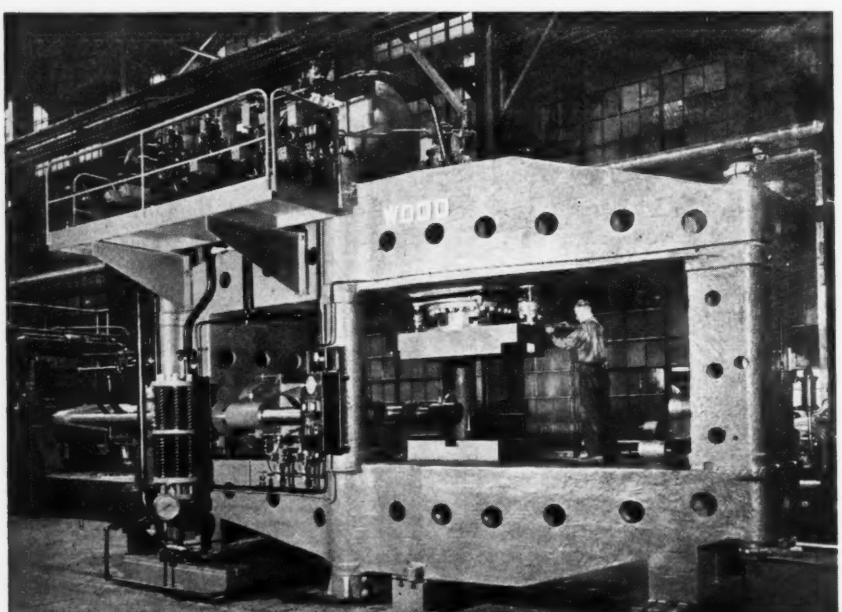
Any desired number of multiple fixtures can be used at one time, the only limit being the length of the machine table. The center-to-center distance between the collets is 3 1/3 inches in the case of 1-inch fixtures, and 5 1/2 inches in the case of 2-inch fixtures. Two fixtures can be staggered, however, to reduce the distances to 1 3/4 and 2 3/4 inches, respectively. Where the milling machine is equipped for "climb cutting," two fixtures can be mounted on each side, making a total of sixteen collets in one set-up. By forcing the coolant upward the chips are washed away from the tool, thus preventing clogging of the fixture. 77

Wood Hydraulic Upsetting Press

The R. D. Wood Co., 400 Chestnut St., Philadelphia 5, Pa., is building a new hydraulic upsetting press designed to perform upsetting operations on light-weight tubular railway axles. After one end of the seamless steel axle tubing is heated, it is delivered to the upsetting press where, by means of external dies and an internal mandrel, the tube end is upset to the desired dimensions. This operation is then repeated on the other end of the axle, an air cylinder being arranged to move a spacing block into position for locating the work.

The press has a rated working capacity of 600 to 900 tons. The top and bottom castings are supported by heavy pieces that are keyed and bolted together by six pre-shrunk strain rods.

The press operates on a semi-automatic cycle basis. The clamping ram is 28 inches in diameter and has a 12-inch stroke. This ram clamps the tube before the horizontal ram begins the working stroke. After the working stroke is completed, the 23- by 22-inch horizontal ram is stripped from the tube. 78



Hydraulic Press Designed for Upsetting Ends of Tubular Railway Axles

Pope Equipment for Balancing Grinding Wheels

Pope Grinding-Wheel Balancing Equipment

Although grinding-wheel holders have adjustable weights for balancing purposes, it requires considerable time and skill to so adjust these weights that accurate balance is obtained. In order to facilitate rapid and accurate balancing of grinding wheels, the Pope Machinery Corporation, Haverhill, Mass., has brought out a balancing kit consisting of a wheel-holder, stand, and arbor. These three parts are assembled as shown in the illustration for the balancing operation.

After making sure that the tops of the ways of the stand are level, the grinding wheel, mounted on the holder, is placed on the ways and allowed to come to rest. A simple marking gage furnished with the kit is used to place pencil marks on the rim of the wheel-holder while the wheel is at rest. A vertical chalk mark on the light side of the wheel cover—that is, the top side—indicates the direction toward which the weights will be set.

After the wheel assembly has been removed from the stand, it is placed on the Pope bench block, which is part of the kit. With the weights adjusted toward the chalk marks, the assembly is put on the balancing stand again, using the pencil marks to line up the rear edges of the weights. The weights are then so adjusted that each is an equal distance from its pencil mark, adjustment continuing until accurate balance is achieved. It is obvious, in placing the assembly on the stand, that if the chalk mark moves downward, the weights are too heavy and must be moved far-

To obtain additional information on equipment described on this page, see lower part of page 216.

Increased Production from Lathes Built to Produce

● The Sidney Continuous Tooth Herringbone Geared Head is not only distinctive in design but is based on sound engineering principles. The Headstock, while only one of the component units of the lathe, is the unit that merits the purchaser's most serious consideration.

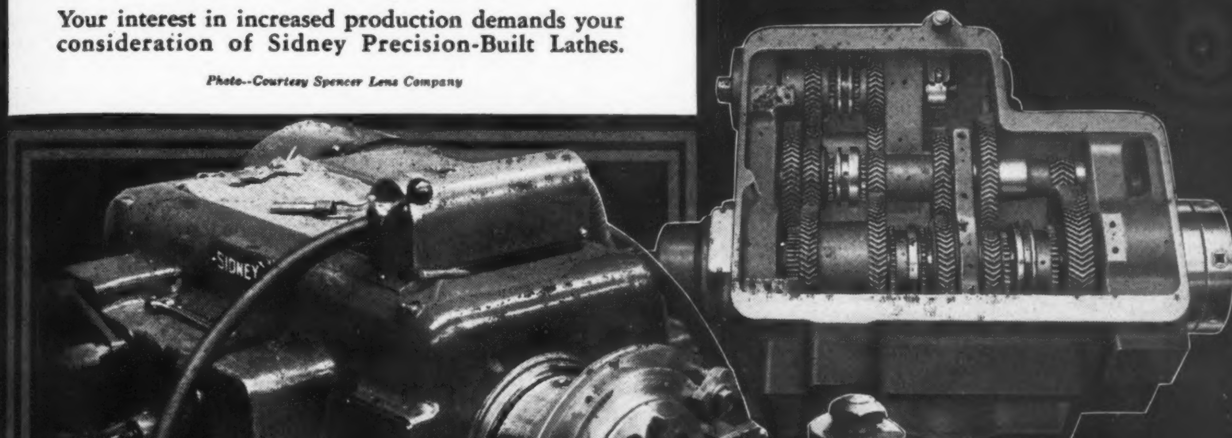
Illustration shows the exclusive Sidney Headstock transmission, providing 16 selective spindle speed changes, with all the gears in constant engagement, and speed changes secured by means of sliding clutches of the internal and external involute tooth type operating on multiple spline shafts. Precision, rigidity and stamina are built right into this unit resulting in a smooth flow of power, finished work free of tooth marks, minimum of maintenance attention and a definite increase in production.

Your interest in increased production demands your consideration of Sidney Precision-Built Lathes.

Photo--Courtesy Spencer Lens Company

SIDNEY LATHES

with Continuous Herringbone Geared Head



The SIDNEY MACHINE TOOL *Company*

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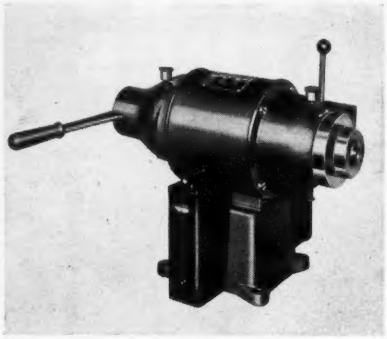
ther apart; if the movement of the chalk mark is upward, the weights must be moved nearer to the chalk mark.

The balancing kit is suitable for use with wheels up to 8 inches in diameter, 3/4 inch wide, with a center hole 1 1/4 inches in diameter, such as are used on 6- by 18-inch surface grinders and similar equipment. 79



Improved Speed Lathe Made by Schauer Machine Co.

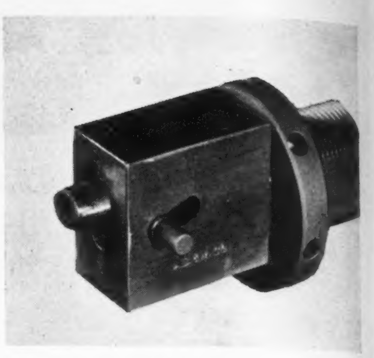
Schauer General-Purpose Speed Lathe

Engineering refinements and mechanical improvements have been incorporated in a new model, general-purpose, speed lathe brought out by the Schauer Machine Co., 2069 Reading Road, Cincinnati 2, Ohio. This new lathe is especially designed for burring, lapping, polishing, or finishing small metal or plastic parts such as are usually handled in spring type collets. It is of streamline appearance, cooled by forced ventilation, and is equipped with a filter that removes dust and abrasive particles from the cooling air to prevent injury to the motor and machine. A new switch of the fully enclosed type eliminates danger of switch breakdown under adverse operating conditions. The control lever is of the ball-handle type. 80

Pull-Head for Small Round-Shank Broaches

A broach pull-head of the round pin type, designed for either manual or automatic operation, is being manufactured by the American Broach & Machine Co., Ann Arbor, Mich., for use with small pull type broaches having shanks up to 1/2 inch in diameter. The shanks of the broaches used with this head have a half-round groove across the pulling end. When the broach shank is pushed into the pull-head to the holding position, the locking pin automatically slips into the notch in the broach shank. Sufficient mechanical pressure is provided in back of the pin to seat it positively in the notch. This provides not only a positive pulling means, but also a positive radial positioning of the broach, which is a desirable feature, especially in the case of small broaches that must be accurately located in relation to the work. After being automatically connected to the pull-head, the broach can be released by pushing the cross-pin with the thumb and forefinger.

Provision is made for automatically releasing the broach if desired. A plunger just above the bore which receives the broach is tapped to receive a screw that can be adjusted to make contact with the reducing bushing, so that on the return stroke of the machine the pressure on this screw will cause the plunger to recede and release the cross-pin. The broach can then be removed without touching the pull-head. When the broaching operation calls for a permanently locked broach which does not have to be removed from the pull-head at the completion of each stroke or operation, the knock-off screw in the plunger is removed. This permits the broach to be permanently locked in place until it is desired to remove it manually. ...81

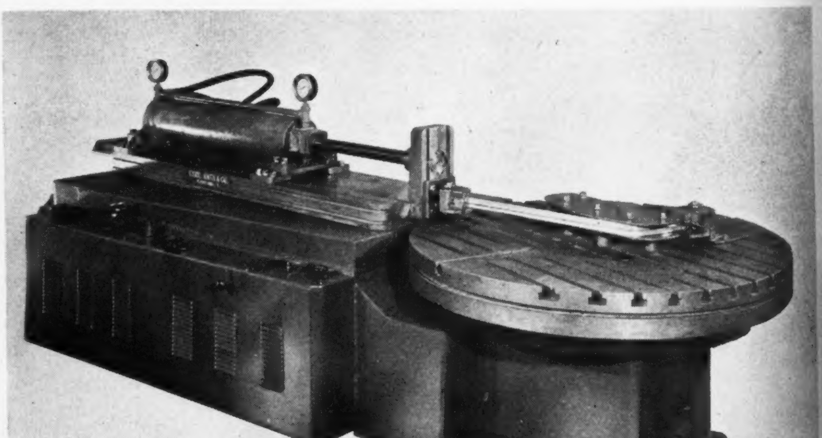


Pull-head for Small Broaches Made by American Broach & Machine Co.

Jaws for Universal Rotary Stretching or Contour Forming Machine

The Cyril Bath Co., E. 70th and Machinery Ave., Cleveland 8, Ohio, has developed a semi-standard stretching head with jaws for use in connection with stretch type forming presses previously brought out by this company. Considerable research work was conducted in the development of these heads to obtain a low-cost and efficient design that would operate quickly and with a minimum of gripping length without marring the work.

The casing of the head is made in various sizes, and can be fitted with jaws that provide either two,



Bath Universal Rotary Stretching Machine Equipped with Special Jaws

To obtain additional information on equipment described on this page, see lower part of page 216.

three, or four angular sliding movements to permit gripping work of almost any shape evenly and securely. These heads can be adapted for pulling extruded shapes, brake-formed or rolled sections, and flat sheet work. They have been used successfully on all grades of aluminum alloys and stainless steel. The smaller size jaws can be released by hand, while the larger size jaws can be clamped and released by either air or hydraulically operated cylinders equipped with suitable controls.

A universal rotary stretcher used in forming a tank strap is shown in the illustration. The leg portion of this strap is required to retain its position in the horizontal plane, while the angular positioning of the flange is changed as much as 15 degrees in forming the length of the member. The jaws are so constructed that different inserts can be used to accommodate work of different shapes. The work is loaded into the jaws by simply pushing it into place. Unloading is accomplished quickly by pulling the release handle forward and removing the stock. 82

Precision Countersink Cutters Made by Farnham Mfg. Co.

"Airgrip" Two-Jaw Compensating Chuck

A new two-jaw compensating finger type chuck is being added to the line of "Airgrip" air-operated three-jaw chucks and collets made by the Anker-Holth Mfg. Co., 332 S. Michigan Ave., Chicago 4, Ill. The illustration shows one of these new chucks designed to hold the casting shown at the left. This chuck is so arranged that the work is located from a finished round shoulder on the bottom of the casting and by two hardened and ground pins, which also serve as drivers.

The plate on the face of the chuck is hardened and ground, and the two jaws are so designed that either one can be pulled in farther than the other to compensate for variations in the thickness of the work. The chuck body is made for direct mounting on American standard spindle noses, but it can be mounted on any spindle by employing an adapter. These chucks are made in various sizes, and are furnished for second-operation work, which must be concentric with the locating surface within extremely close limits. 83

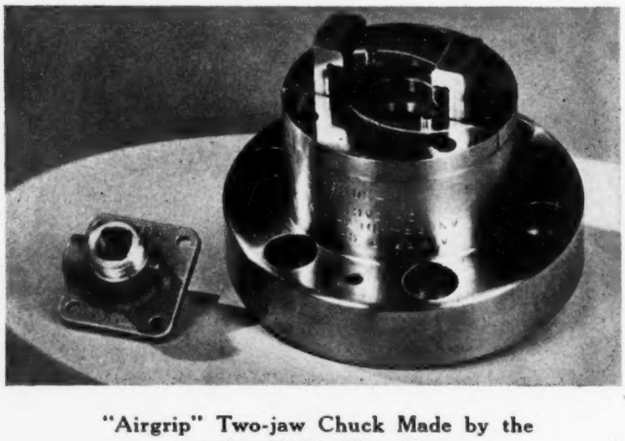
Farnham Countersink Cutters

As a result of continuous tests on regular aircraft production work extending over a year and a half, the Farnham Mfg. Co., Seneca and Elk Sts., Buffalo, N. Y., has developed a new line of precision countersinking cutters for use on all types of countersinking machines and devices. These cutters were originally made only for Farnham mill countersinkers, which have been used in aircraft production for the last three years. Increased manufacturing facilities have now made them available for use on other machines.

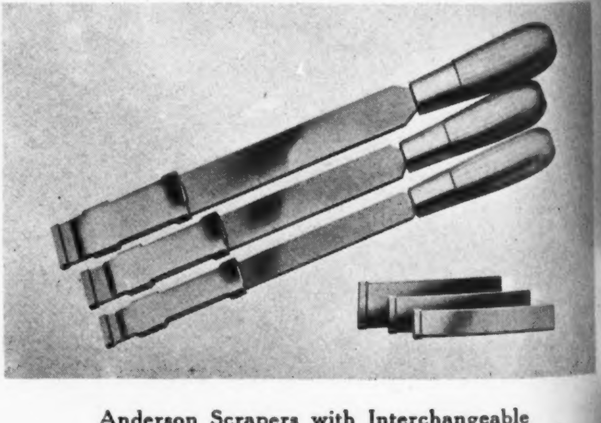
These cutters are available in a wide range of sizes and rivet-head angles to meet production requirements for 3/8-, 1/2-, 5/8-, and 13/16-inch body diameters. In addition to the standard sizes, Farnham cutters are also made in the built-in pilot style. These cutters can be used for several sizes of holes by applying interchangeable pilots. Special cutters for unusual work are also available. 84

Anderson Carboloy-Tipped Scraper Blades

Carboloy-tipped scraper blades are now available in three widths to fit the standard line of hand scrapers made by Anderson Bros. Mfg. Co., 1907 Kishwaukee St., Rockford, Ill. It is only necessary to slip the Carboloy-tipped blade in



"Airgrip" Two-jaw Chuck Made by the Anker-Holth Mfg. Co.



Anderson Scrapers with Interchangeable Carboloy-tipped Blades

To obtain additional information on equipment described on this page, see lower part of page 216.

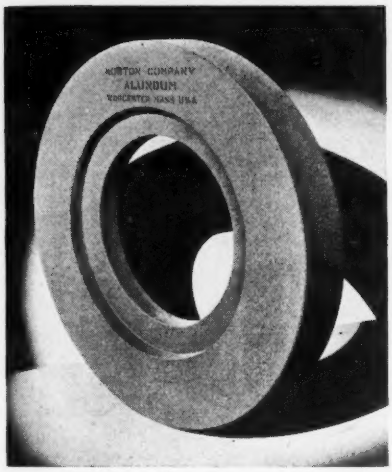

INDUSTRIAL AND PRECISION GEARS
• SPEED REDUCERS • MOTORIZED
REDUCERS • AIRCRAFT DEVICES

the holder after removing the high-speed steel blade. Tests of the new blade in some of the largest manufacturing plants have proved that the Carboloy-tipped blades give eight to ten times longer service than the ordinary blade. 85

Combustion Control Equipment for Small Power Plants

The Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa., has developed a new system of combustion control designed to give small industrial and municipal power plants the same service as that furnished to large central stations by the "Metermax System," built by this company. The new system, known as Type P, is applicable to boilers fired with coal, oil, or gas. It continuously proportions the fuel and air to meet the steam demands, and at the same time controls the furnace pressure.

By means of push-buttons on the control panel, the operator can switch from full automatic control to separate push-button control and regulation of each unit or any desired combinations of units that serve to regulate the air and fuel supply. 86



Norton Wheel Made of 57 Alundum Abrasive

Norton Alundum Abrasive Wheel

The Norton Co., Worcester 6, Mass., has announced that grinding wheels made of the company's 57 Alundum abrasive are now available for general use. This abrasive is an improved aluminum-oxide product which was developed by the Norton research laboratories several years ago. It has proved a very successful abrasive for wheels used for cylindrical grinding, centerless grinding, internal grinding, and snagging operations at comparatively low speeds.

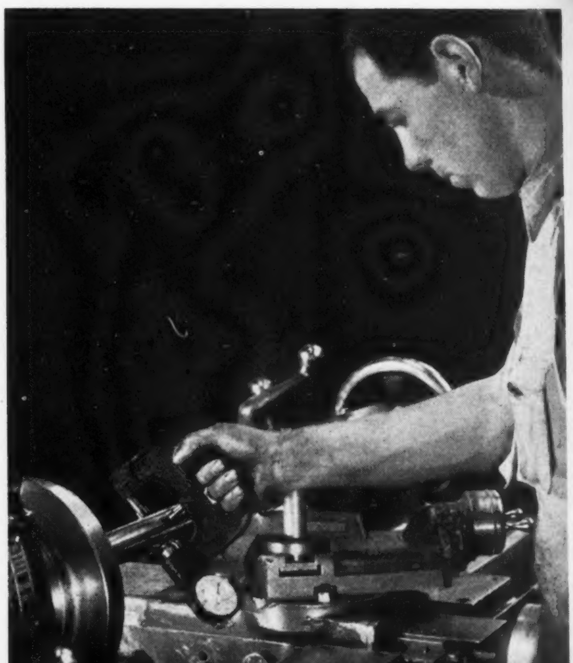
Wheels of 57 Alundum, being more friable than those of regular Alundum, have a fast, cool cutting action, as they tend to keep themselves sharp; yet they also have the ability to retain their shape with comparatively few dressings. They have been especially useful in crankshaft grinding, where the ability of the wheel corner to stand up is very important. These wheels are available in the patented Norton BE vitrified bond, as well as in regular vitrified bond, in a wide range of grain sizes, grades, and structures. 87

Sheffield Dial-Indicator Adjustable Snap Gages

An improved line of dial-indicator adjustable snap gages has been developed by the Sheffield Corporation, Dayton 1, Ohio, to fill the gap between the conventional snap gage and the high-precision visual gage. This line of gages includes twelve models covering a range of sizes up to 12 inches. Larger sizes can be supplied to suit customer's specifications.

One of the most important appli-

Leeds & Northrup Combustion Control Equipment for Small Power Plants



Sheffield Dial-indicator Adjustable Snap Gage for Checking Rotating Work

To obtain additional information on equipment described on this page, see lower part of page 216.

cations of these gages is in checking work as it is being brought to size by grinding or turning. It can be used as a comparator type of check without removing the work from the machine. This saves considerable time on production runs, and fills the needs of small shops, as well as large plants, for close dimensional control over machining, grinding, and lapping operations. It is also adapted for inspecting finished parts at the bench or for classifying parts of such size or weight that they cannot be checked by comparators of other types.

The shockproof dial indicator is 2 1/4 inches in diameter, and has 0.0001-inch graduations. It is of the balanced type, with plus and minus indicator readings to 0.005 inch. The range per revolution of the hand is 0.010 inch. When properly set, the hand will make 1 1/4 revolutions in either direction, the total range of the indicator being 0.025 inch.

In using this snap gage, the normal position of the indicator is at the lower end of the gage frame. This permits the weight to be carried on the stationary anvil instead of on the gaging anvil, an arrangement that gives maximum accuracy. However, the gage can be used with the indicator at the top when this arrangement is desired.

The adjustable anvil has a range of 1 inch. The gage frame is light in weight, yet sufficiently rigid and free from stresses. Serrated plastic grips on each side of the gage frame insulate it against transmission of heat from the operator's hands. 88

General Electric Thyratron Welding Control and Helium-Shielded Electrode-Holder

A new thyratron welding control designed to provide precise control of low-capacity spot-welders has been developed by the Industrial Control Division of the General Electric Co., Schenectady, N. Y. This new control, shown in Fig. 1, when coupled with a suitable welding transformer, can be used with either welding tongs or a small bench type welder. It is especially adapted for the spot-welding of vacuum tube parts.

The control is mounted in a compact metal enclosure designed for attachment either to the top of the assembly bench or underneath it. A single calibrated time adjustment on the front panel provides for one-half cycle operation or operation on any number of complete cycles from one to ten. The removable cover permits quick inspection and access to all parts of the unit.

A new helium-shielded arc-welding electrode-holder for manual operation, shown in Fig. 2, has just been announced to the trade by the Electric Welding Division of the General Electric Co. This holder can be used with either helium or argon gas. It is especially designed for welding light metals, such as magnesium and its alloys, where precise heat control and protection from the oxidizing effect of the air are required. It can also be used for welding other metals, such as aluminum and stainless steel, that are ordinarily classed as "hard to weld" metals. 89

Reimuller "Hy-Speed" Gap Type Hydraulic Press

Reimuller "Hy-Speed" Hydraulic Press

A rugged gap type "Hy-Speed" hydraulic press, of all-steel construction, with simplified hydraulic foot control has been added to the line of Reimuller Brothers Co., 9400 Belmont Ave., Franklin Park, Ill. This press is designed for the fast handling of assembling, broaching, grooving, riveting, sizing, straightening, marking, forming, and many other small press operations. It is made in two models, of 10- and 20-ton capacities with an overload capacity rating of 50 per cent.

Only two levers are used in the hydraulic foot control, one of which serves to apply pressure as rapidly or as slowly as desired, while the other controls the release of the

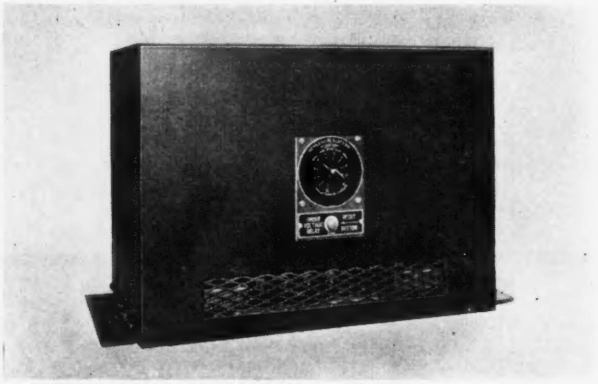


Fig. 1. General Electric Thyratron Welding Control

Fig. 2. General Electric Helium-shielded Electrode-holder

To obtain additional information on equipment described on this page, see lower part of page 216.

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MACHINERY'S DATA SHEETS 509 and 510

STANDARD COMMERCIAL COPPER-BASE ALLOYS—1

Kind of Alloy	Chemical Composition, Per Cent					
	Copper	Lead	Tin	Iron	Manganese	Zinc
Plain Brasses, Non-Leaded						
Gilding Metal	93.5–96.5	....	....	....	....	Remainder
Commercial Bronze	89.0–92.0	....	....	....	....	Remainder
Red Brass	83.0–86.0	....	....	....	....	Remainder
Low Brass	78.5–81.5	....	....	....	....	Remainder
70/30 Brass	68.5–71.5	....	....	....	....	Remainder
High Brass	63.0–67.5	....	....	....	....	Remainder
Muntz Metal	59.0–63.0	....	....	....	....	Remainder
Leaded Brasses						
Leaded Commercial Bronze	87.5–90.5	1.25–2.25	....	....	....	Remainder
Low-Leaded Tube Brass	65.0–69.0	0.30–0.80	....	....	....	Remainder
High-Leaded Tube Brass	65.0–69.0	1.25–2.00	....	....	....	Remainder
Light-Leaded Brass	63.5–67.5	0.15–0.35	....	....	....	Remainder
Low-Leaded Brass	62.5–66.5	0.30–0.70	....	....	....	Remainder
Medium-Leaded Brass	62.5–66.5	0.75–1.25	....	....	....	Remainder
High-Leaded Brass	60.5–64.5	1.25–2.25	....	....	....	Remainder
Extra High-Leaded Brass	60.0–64.0	2.00–3.00	....	....	....	Remainder
Free-Cutting Brass	60.0–63.0	2.50–3.75	....	....	....	Remainder
Leaded Muntz Metal	58.0–62.0	0.35–0.90	....	....	....	Remainder
Free-Cutting Muntz Metal	59.0–62.0	0.90–1.40	....	....	....	Remainder
Forging Brass	58.5–62.0	1.50–2.50	....	....	....	Remainder
Architectural Bronze	55.0–60.0	2.00–3.75	....	....	....	Remainder
Tin and Aluminum Brasses*						
Admiralty	70.0–73.0	....	0.90–1.20	....	....	Remainder
Naval Brass	59.0–62.0	....	0.50–1.00	....	....	Remainder
Leaded Naval Brass	59.0–62.0	1.25–2.25	0.50–1.00	....	....	Remainder
Manganese Bronze	57.0–60.0	....	0.50–1.50	0.80–2.00	0.50 max.	Remainder

*Aluminum Brass has 76.0-79.0 copper, 1.75-2.50 aluminum, and the remainder zinc.

Based upon compilation of Copper and Brass Research Association

STANDARD COMMERCIAL COPPER-BASE ALLOYS—2

Kind of Alloy	Chemical Composition, Per Cent					
	Tin	Phosphorus	Nickel	Silicon	Copper	Zinc
Phosphor-Bronzes						
Phosphor-Bronze, Grade A	3.50– 5.80	0.03–0.35	....	....	Remainder	....
Phosphor-Bronze, Grade C	7.00– 9.00	0.03–0.35	....	....	Remainder	....
Phosphor-Bronze, Grade D	9.00–11.00	0.03–0.25	....	....	Remainder	....
Phosphor-Bronze, Grade E-1	1.50– 2.00	Trace	....	....	Remainder	....
Phosphor-Bronze, Grade E-2	1.00– 1.50	Trace	....	....	Remainder	....
Cupro-Nickel and Nickel Silver						
Cupro-Nickel	....	....	29.0–33.0	....	Remainder	....
Nickel Silver, Alloy A	....	....	17.0–19.5	....	63.0–66.5	Remainder
Nickel Silver, Alloy B	....	....	17.0–19.5	....	53.5–56.5	Remainder
Silicon Bronzes (Copper-Silicon Alloys)						
Silicon Bronze, Type A	....	....	....	2.75–3.50	94.8 min.	....
Silicon Bronze, Type B	....	....	....	0.75–2.00	96.0 min.	....
Silicon Bronze, Type D*	....	....	....	....	....	....

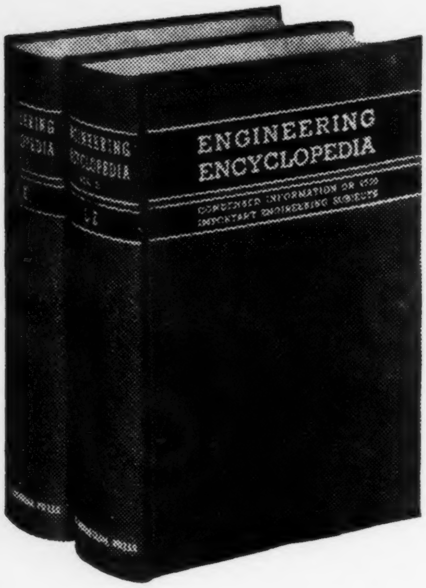
*Silicon Bronze, Type D, has 94.0 min. copper, 2.75-3.50 silicon, and 0.20-0.80 lead.

The alloys listed in these Data Sheets are standard in the sense that over a period of years they have been the ones most commonly ordered in large quantities by consumers.

In addition to these alloys, there are many special and proprietary alloys that can be and are produced by the mills for various uses, including aluminum bronzes, cadmium bronzes, beryllium coppers, aluminum-tin bronzes, aluminum-silicon bronzes, silicon bronzes, copper-chromium alloys, etc.

Based upon compilation of Copper and Brass Research Association

A World of Engineering Knowledge in Two Volumes



The Engineering Encyclopedia is for everyone who can use essential facts about thousands of standard and special engineering subjects. It consists of clearly written concise treatises, definitions of terms used in engineering and manufacturing practice, and the results of many costly and important tests and experiments.

This work of reference supplies such practical and useful information as the important mechanical laws, rules, and principles; physical properties and compositions of standard and special metals used in machine construction and other engineering structures; characteristic features and functions of machine tools and other manufacturing equipment, and many other subjects. 1431 pages of condensed and practical information on 4500 subjects illustrated by 206 drawings. Price, $8.00 set.

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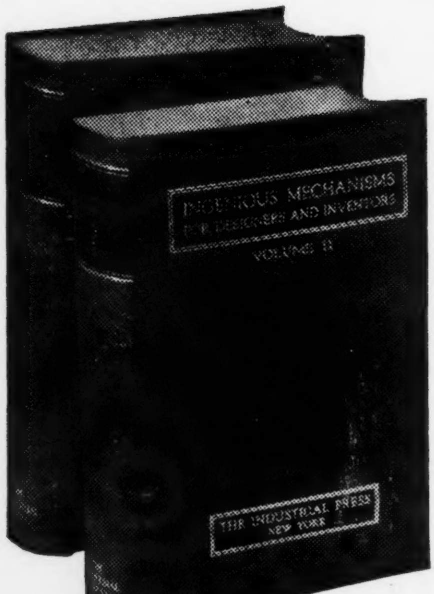
Ingenious Mechanisms for Designers and Inventors

Two Books that Form a Complete Course of Study



To own these two volumes is to have a comprehensive encyclopedia of mechanical movements unparalleled in scope and usefulness. Each volume is an entirely independent treatise on mechanisms; both books are similar in size and general character, but the contents are different.

Every mechanism described and illustrated embodies some idea or principle likely to prove useful to designers or inventors. Volume I contains 536 pages and 300 illustrations; Volume II, 538 pages and 303 illustrations. Price, $8 set or $5 for either book separately.

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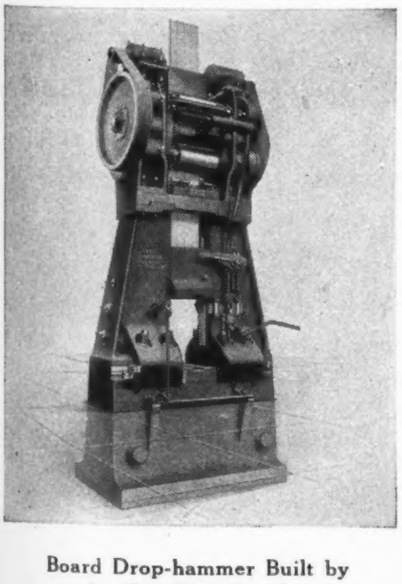
work. This arrangement leaves the operator's hands free for handling the work.

The large hollow ram receives punches, dies, and other fixtures. Packless sealing rings, aircraft style piston-ring plungers, and twin pressure gages showing the system pressure are features of this press. The press is portable, and can be quickly shifted to any machine or bench. 90

Erie Board Drop-Hammer

The 7500-pound, four-roll, board drop-hammer with self-contained motor drive shown in the accompanying illustration has just been brought out by the Erie Foundry Co., Erie, Pa. This machine is so designed that it can be built in a 10,000-pound size, the rating of the press representing the actual weight of the ram. The ram of the press illustrated weighs 7500 pounds, and the anvil 150,000 pounds. However, all the other parts of the hammer are so designed that they can be used with a ram weighing 10,000 pounds and an anvil weighing 200,000 pounds, the only other change required being a slight increase in the weight of the friction bar and the use of larger motors.

The motors are mounted on the top of this hammer to avoid overhang. The motor cushioning device is of all metallic construction, and provides a greater amplitude of movement than the rubber type cushioning previously employed. 91



Board Drop-hammer Built by the Erie Foundry Co.

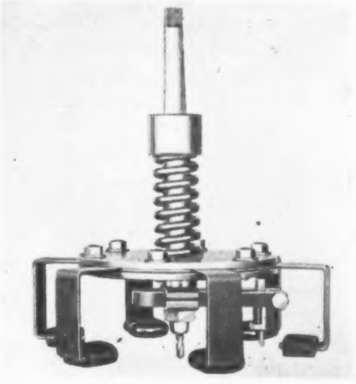
Coolant System for Rogers Vertical Turret Mills

A special coolant system has been developed by the Rogers Machine Works, Inc., 125 Arthur St., Buffalo 7, N. Y., for the standard and high-speed models of the "Perfect 36" vertical turret mills built by this company. The system is applicable both to new mills and to those already in operation. It delivers two streams of coolant to the tool and the work through flexible tubing. The pump, driven by a direct-connected fractional-horsepower motor, is mounted on the machine base, the pump unit being self-contained, enclosed, and self-primed. The pump starting switch is connected to the main machine switch to insure positive coolant flow during all machining operations. The coolant flows back to the lowest point on the frame, where it is cleaned and recirculated to the tool and work. 92

Rogers Vertical Turret Mill Equipped with Coolant System

Self-Clamping Adjustable Circle Cutting Tool

Circular holes from 1 1/2 to 8 inches in diameter can be cut in metal, plastics, wood, and other materials without the use of clamps by means of a tool recently placed on the market by the Corlin Mfg. Co., Dept. D, 3201 Clinton Ave., Minneapolis 8, Minn. Adjustable feet on the tool are forced down by spring pressure to hold the material close to the cutting circumference, thus preventing bulging and distortion even when cutting thin sheets.



Circle Cutting Tool Made by Corlin Mfg. Co.

The extra heavy U-shaped beam which slides between the two channel type washers prevents changing of the setting after the clamping nut is tightened. A heavy-duty ball thrust bearing carries the load exerted by the spring. A cutting tool without the hold-down clamping feature can be furnished. 93

J & S Radii and Angle Dresser for Form Grinding Wheels

The J & S Tool Co., 477 Main St., East Orange, N. J., has brought out an improved radii and angle dresser designated Model E. An important new feature of this

"Fluid-Motion" Dresser for Form Grinding Wheels

To obtain additional information on equipment described on this page, see lower part of page 216.

dresser, called "Fluid-Motion," provides a means for accurately dressing form grinding wheels in such a manner that angular and tangent radius-formed surfaces are produced on the grinding wheel face with smooth continuous passes of the truing diamond, leaving the formed outline of the wheel clean, accurate, and free from chatter or vibration marks.

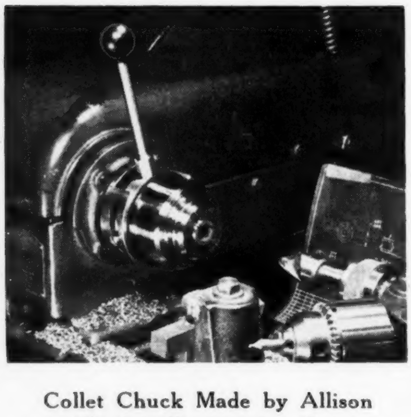
This dresser is adapted for both precision tool-room operations and production work. It has a range for forming concave and convex radii from 0 to 3 inches, and is designed to hold work to a tolerance of 0.0001 inch. It can be used for dressing wheels up to 14 inches in diameter, and has an angular travel of 2 1/4 inches. The base is 4 by 5 inches, and the height 8 1/8 inches. The maximum height of the diamond point from the base is 7 1/2 inches. The dresser weighs approximately 15 pounds. 94

Allison Collet Chuck

The Allison Tool & Engineering Co., 4031 Whittier Blvd., Los Angeles 23, Calif., is placing on the market a new collet chuck made in two sizes, one for 1 1/2-inch spindles, eight threads per inch, with a collet capacity of 7/8 inch, and the other for 2 1/2-inch spindles with a collet capacity of 1 5/8 inches.

This chuck operates on an entirely new principle which employs a full circular, low-pressure cam to actuate the collet closing mechanism, and assures the user any desired pressure for gripping various materials. One of the advantages claimed for the circular cam arrangement is that it provides a uniform clamping pressure around the work, thus reducing distortion resulting from uneven application of pressure.

Very little pressure is required on the operating handle, which is moved only a short distance to close or open the collet. The operating handle travels at right angles to the ways of the lathe bed, allowing the operator one free hand to insert and feed the stock or operate the bed turret, a feature that adapts the chuck for use on automatic screw machines. 95



Collet Chuck Made by Allison Tool & Engineering Co.

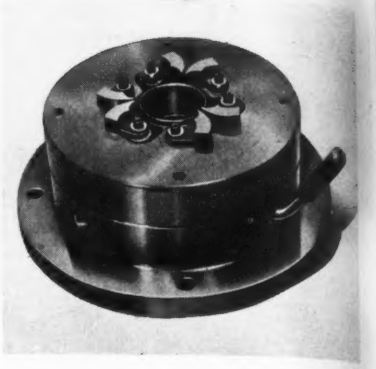
Vard Spherical Segment Gage

A gage of special design for checking ball and spherical cavity fittings has been brought out by Vard Inc., 2961 E. Colorado St., Pasadena 8, Calif. This new gage consists of a tool-steel gaging member of true spherical segment shape, attached to a knurled handle, as shown in the accompanying illustration. It can be used for rapid, accurate gaging of ball sockets or spherical cavities, revealing any machining errors. The gage is made in "Go" and "No Go" types. 96

Spherical Segment Gage Made by Vard Inc.

"Match-It" Gear Chuck

A gear chuck known as the "Match-It," which is designed for use in precision boring or grinding the holes or bores in gears, is a new product of the LeMaire Tool & Mfg. Co., Dearborn, Mich. The chuck is so designed that the clamping pressure on the gear when being machined is applied in the same direction as the driving force normally exerted on the mating gear. Since this pressure is always exerted on the tooth, and not toward the center of the gear, the manufacturer claims that distortion of delicate gears from the clamping pressure is greatly reduced.



Gear Chuck Brought out by LeMaire Tool & Mfg. Co.

The chuck is designed to accommodate both helical and spur gears with either external or internal teeth. It is adapted for use in finish-boring, facing, and counterboring operations, and also for grinding and finish-shaping the teeth of one gear of a cluster, such as is used in the sliding gear transmission of an automobile. 97

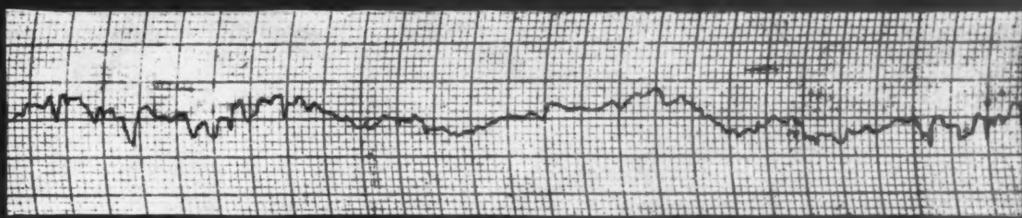
"Flat Top" Work-Holding Fixture

A simplified type of fixture for holding small flat work, designed for tool-room use and certain types of production operations, has been brought out by the Mead Specialties Co., 15 S. Market St., Chicago 6, Ill. This holder or fixture was

Mead "Flat Top" Work-holding Fixture

To obtain additional information on equipment described on this page, see lower part of page 216.

Proof of a Better Finish



Surface Analyzer Tapes Show You Get A Better Finish With Chicago Wheels

These results were obtained at a rate of 10 pieces per hour in an aircraft parts plant. Material, X-13-15, Rockwell 60 to 57, grinds out .006 to .007 stock. Chicago Wheel used, ½ x ½ x ⅛", Grain 180, Grade L Arcite. Spindle Speed 40,000 r.p.m. Lapping and super finishing eliminated on this job.

Can you match that finish? Sounds phenomenal, but you can do the same thing with Chicago Wheels.

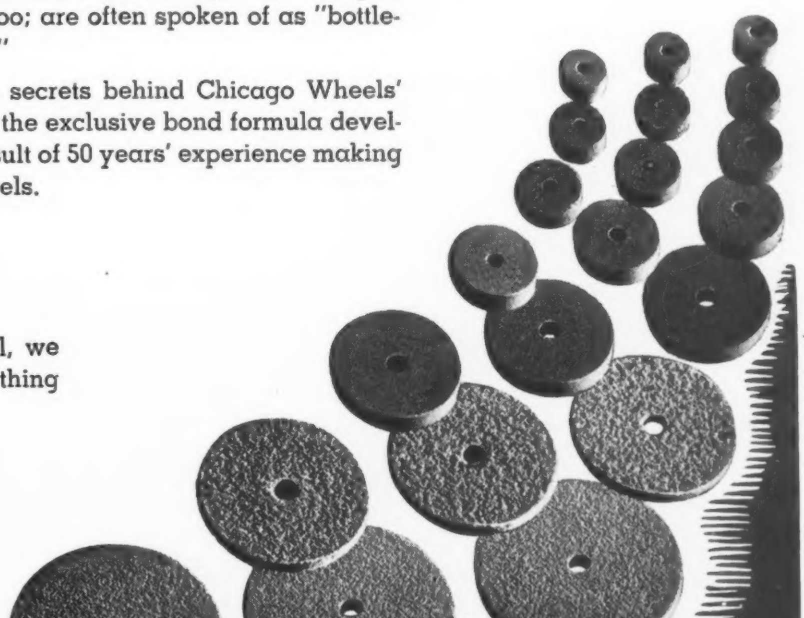
Squint your eye along the surface, test it by "feel" or be scientific and use a surface analyzer to measure your finish in micro inches — you'll find that Chicago Wheels give you better finishes, hold closer tolerances and have longer life. They're mighty fast, too; are often spoken of as "bottle-neck busters."

One of the secrets behind Chicago Wheels' superiority is the exclusive bond formula developed, as a result of 50 years' experience making grinding wheels.

Now Featuring Wheels Up to 3" in Diameter

For the duration, with full WPB approval, we are specializing on the small sizes — anything up to 3" in diameter.

Write for Catalog and we will include Engineering Survey Forms helpful in getting the right solution to your own grinding problems.



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developed to overcome difficulties encountered in drilling, countersinking, and tapping small precision parts in which highly accurate perpendicular positioning of the work is essential. It will hold any type of work that is flat on the bottom, of a thickness varying from a few thousandths of an inch up to 2 inches, and having an area ranging from the size of a dime up to several square inches. Work having an irregular peripheral contour can be held on this fixture.

The fixture is not limited to drilling and tapping operations, but can also be used in performing many operations on small shapers and bench milling machines. One of the supporting plates is perforated and provided with three studs that can be inserted in the perforations. This end of the fixture is used for milling and shaping work. Two studs are set in position to locate the back of the work, while the third is set at the end to support the work against the pressure of the cutting tool. The fixture can be changed from one set-up to another by simply dropping the three locating studs into the proper holes in the plate. Adjustment for work thickness is obtained by simply turning the knurled head of the ball-joint stud. 98

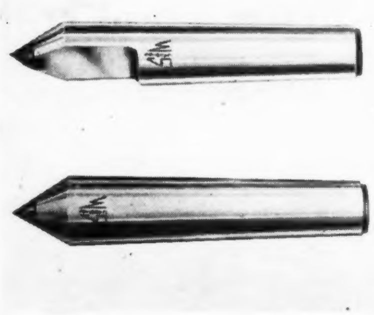
Forss Aircraft Riveting Hammers

The Forss Pneumatic Tool Co., 1827 Broadway, Rockford, Ill., is introducing to the trade a new line of "slow hitting" aircraft riveting hammers of compact design. Outstanding features claimed for these new hammers include efficient control, smooth operation, ease of handling, and power. They have two-finger trigger control, a metered air throttle valve, and an improved offset handle. Good balance and easy operation make them especially adapted for use by women operators. 99

Forss "Slow Hitting" Riveting Hammers

Carbide-Tipped Lathe Centers

Carbide-tipped lathe centers and half-centers in standard taper sizes are being made by the Wendt-Sonis Co., Hannibal, Mo., with deeper tipped inserts to give longer service life. The extension of the carbide-tipped inserts into the shank is approximately equal to that of the exposed portion of the tip. This additional length of carbide insert makes it possible to regrind the center many times before replacement is necessary. Special precision methods are used in making these centers to keep them concentric within 0.0002 inch. 100



Carbide-tipped Lathe Centers Made by Wendt-Sonis Co.

* * *

New Standards for Machine Tools and Accessories

The American Standards Association, 29 W. 39th St., New York 18, N. Y., has recently approved two standards in the machine tool field. One, designated B5.2-1943, relates to tool shanks and toolposts for lathes, planers, shapers, boring mills, and turret lathes; the other, designated B5.18-1943, relates to spindle noses and arbors for milling machines.

Recent Army-Navy "E" Production Awards

The following companies have recently received the Army-Navy "E" Production Award or a renewal of the Award:

Ace Mfg. Corporation, Philadelphia, Pa.

J. G. Brill Co., Philadelphia, Pa.

Brown Instrument Co., Philadelphia, Pa.

Edwards & Co., Norwalk, Conn.

A. F. Holden Co., New Haven, Conn.

Logansport Machine Co., Logansport, Ind.

Moeller Instrument Co., Richmond Hill, Queens, N. Y.

* * *

Baldwin Completes Seventy-Thousandth Locomotive

The seventy-thousandth locomotive built by the Baldwin Locomotive Works, Philadelphia, Pa., has just been turned over to the United States Army. The engine is of the same type as many now being used in military operations abroad. During the 112 years since Matthias Baldwin built the first "Old Ironside," the company has averaged one completed locomotive every fourteen hours for 365 days in the year and twenty-four hours a day. Since on an average, however, the plant has probably operated only, say, ten hours a day for 300 working days a year, it might be said that the plant has completed a locomotive about every five working hours during a period of 112 years.

* * *

Hydraulic Extrusion Press for Experimental Work

A press designed to aid laboratory and experimental work in a wide range of extrusion processes has been developed by the Moslo Machinery Co., Cleveland, Ohio. The equipment combines a laboratory type 12-ton hydraulic extrusion press and an automatic wire feed unit in one machine which occupies only 2 by 4 feet of floor space. While designed primarily for the extrusion of welding rods, the press may be provided with dies for extruding powdered metals, carbon, and certain plastics.

To obtain additional information on equipment described on this page, see lower part of page 216.

News of the Industry

California

H. M. Comstock, for more than fifteen years director of sales for the Simplex Products Corporation, Cleveland, Ohio, has been made engineering sales representative of the Kropp Forge Co. and the Kropp Forge Aviation Co., Chicago, Ill. Mr. Comstock will handle the southern California territory. His offices will be in the Clem Lane Bldg., Wilshire and LeBrea Blvds., Los Angeles, Calif.

Progressive Welder Co., Detroit, Mich., has opened a factory branch office at 1007 Broxton Ave., Los Angeles 24, Calif., to serve the Los Angeles industrial area. Howard Dally and A. N. Seedorf are field engineers at the new branch.

McCarty Co., 1206 Maple Ave., Los Angeles, Calif., advertising counsellors, celebrated last month the twenty-fifth anniversary of the founding of the company. The agency is still serving many of its original clients.

Illinois and Missouri

Gray-Mills Co., manufacturer of portable coolant systems for the metal-working industries, has moved from 215 W. Ontario St., Chicago, to a new plant at 1948 Ridge Ave., Evanston, Ill. The new factory is a two-story structure containing 50,000 square feet of floor space, which is more than double the space formerly available. The move was made necessary by the steady growth in the output of the company's products.

D. I. Packard has been appointed Chicago district manager of the Baldwin Locomotive Works, Philadelphia, Pa., succeeding Charles Riddell, who has held that post since 1905. Mr. Riddell has been connected with the company for sixty-one years, and will continue to serve the concern as special representative.

Electro Plastic Processes, 2035 W. Charleston St., Chicago 54, Ill., has taken over the new process of metal plating on plastics, glass, and other materials developed by the Precision Paper Tube Co. Equipment for such metal plating is now being installed.

Thompson-Hayward Chemical Co., Kansas City, Mo., has been appointed exclusive representative in the territory covered by that organization for Griffin's Hytemp protective coating made by the Geo. R. Mowat Co., 24 W. 40th St., New York 18, N. Y.

Kentucky and Indiana

Allen-Bradley Co., Milwaukee, Wis., announces that Rietze & Co., 1017 E. Broadway, Louisville 4, Ky., have been appointed sales representatives for the Allen-Bradley line of electric controlling apparatus. The company will handle the southern Indiana and western Kentucky territories.

Cooley Electric Mfg. Corporation, Indianapolis, Ind., is bringing out a standard line of laboratory heat-treating furnaces, in addition to the line of small electric, muffle type furnaces that the company regularly builds for industrial use.

Michigan and Minnesota

B. M. Staley has been appointed factory manager of the Kaydon Engineering Corporation, Muskegon, Mich., maker of large-sized ball and roller bearings. Mr. Staley is a graduate of the Carnegie Institute of Technology, and has held important engineering and managerial positions for the last twenty years.

B. M. Staley, Newly Appointed Factory Manager of the Kaydon Engineering Corporation

B. J. Brugge has been appointed welding engineer in the Detroit, Mich., office of the Lincoln Electric Co. Mr. Brugge has been associated with the company since 1931, and was formerly located in Washington, D. C. He has had a wide experience in all phases of arc welding, and is well qualified to assist companies in the design and fabrication of both present and post-war products.

Lincoln Park Tool & Gage Co., Detroit, Mich., has changed its corporate name to Lincoln Park Industries, Inc. The management and personnel of the organization will remain the same. The merger of Carbur, Inc., manufacturer of cemented-carbide rotary files and cutting tools, with the Lincoln Park Industries, Inc., has also been announced.

Allegheny Ludlum Steel Corporation, Brackenridge, Pa., announces that, in order to consolidate its manufacturing and distribution facilities in the Detroit district, the company has established a new regional managership in that area. H. N. Arbuthnot, assistant general manager of sales, will assume the responsibilities of Detroit regional manager.

Walter C. Ahlers has been appointed Detroit district manager of S K F Industries, Inc., Philadelphia, Pa., manufacturers of ball and roller bearings. Mr. Ahlers succeeds Robert R. Hirsch, who has resigned. Mr. Ahlers has been assistant district manager in the Detroit area for a number of years.

Keller Tool Co., Grand Haven, Mich., is the newly adopted name for the firm formerly known as William H. Keller, Inc. There is no change in the personnel or management of the company, which will continue to manufacture pneumatic tools.

Colonial Broach Co., Detroit 13, Mich., has established a district office in Pittsburgh at 1217 Grant Bldg., with A. Olson in charge, and another district office in Indianapolis at 1109 Fletcher Trust Bldg., with Joe R. Armstrong in charge.

N. A. Woodworth Co., Ferndale, Mich., has purchased the Suprex Co., of Ferndale, manufacturer of precision gages, ground-thread taps, and form tools. The management and personnel of the company will remain the same.

Tungsten Carbide Tool Co., 2661 Joy Road, Detroit 6, Mich., has announced price reductions on the company's line of single-point diamond-ground carbide tools. The reductions range as high as 40 per cent.

Satterlee Co., Minneapolis, Minn., has been appointed exclusive agent in the Minneapolis territory for the milling machines built by the Kent-Owens Machine Co., Toledo, Ohio.

Its simplicity and versatility make the Quickwork-Whiting Model 8 Rotary Shear excellent for both general shop work and straight production of standard forms. The Model 8 is fast in operation (10 to 33 feet per minute), accurate, easy to handle, economical, and modern in design. Its capacity, 1/8 inch mild steel.

Particularly useful with aluminum alloy and stainless steel of the types used in the aircraft industry, the Model 8 Shear adapts itself especially to trimming heavy gauge, irregular, straight and irregular cutting and deep drawn stampings. With special attachments which are available as extras, this shear can be used for flanging, joggling, circle-cutting, and slitting. Write for further information.

ARMY E NAVY

QUICKWORK-WHITING DIVISION

WHITING CORPORATION

15673 LATHROP AVENUE, HARVEY, ILL.

New York, Connecticut and New Jersey

DR. IRVING LANGMUIR, associate director of the General Electric Research Laboratory, Schenectady, N. Y., has been awarded the Faraday Medal of the Institution of Electrical Engineers of Great Britain. The medal, established in 1922, is one of the highest honors in the electrical field. It is given for world-wide services to electrical science and engineering. Plans for its presentation to Dr. Langmuir will be made later.

CHARLES L. FOLEY has been appointed engineering sales representative of the Kropp Forge Co., Chicago, Ill., for New York and adjacent territories. It is also announced that W. R. MOORE, of West Hartford, Conn., no longer serves as New England representative. The state of Connecticut has been taken out of the New England group and assigned to New York.

JACK E. ALLEN has been appointed district sales representative in Buffalo and surrounding territory for the Wyckoff Drawn Steel Co. He will have offices at 525 Liberty Bank Bldg., Buffalo, N. Y.

ALBERT W. HENDRICKSON has been appointed director of employe services of the Farrel-Birmingham Co., Inc. He will be in charge of employment, first aid, training, and other personnel activities at the company's three plants at Ansonia and Derby, Conn., and Buffalo, N. Y.

HARRY K. WERST has been appointed vice-president in charge of manufacturing of the Elastic Stop Nut Corporation of America, Union, N. J. He will be in complete charge of manufacturing processes in the company's plants. Mr. Werst is a graduate of Pennsylvania State College, and was formerly connected with the Baldwin Locomotive Works and the Budd Mfg. Co., of Philadelphia. More recently he was a partner in the firm of Booz, Allen & Hamilton, management engineers of Chicago.

Harry K. Werst, Vice-president in Charge of Manufacturing of Elastic Stop Nut Corporation

Ohio

ROBERT R. HIRSCH has been appointed director of sales of the Bunting Brass & Bronze Co., Toledo, Ohio, succeeding GEORGE H. ADAMS, who recently was made executive vice-president of the company. For the last twenty-five years, Mr. Hirsch has been connected with S K F Industries, Inc., in recent years as district manager of the Detroit and Cleveland areas.

Robert R. Hirsch, Director of Sales of the Bunting Brass and Bronze Co.

H. B. LILLEY, formerly assistant chief inspection engineer of the Steel and Tube Division of the Timken Roller Bearing Co., Canton, Ohio, has been promoted to the position of sales development engineer. He will specialize in the application of tubing to machine tool products and other engineering requirements.

CHARLES ELLISON MACQUIGG, dean of engineering at Ohio State University, has been awarded the James Turner Morehead Medal of the International Acetylene Association for "advancing oxy-acetylene processes through metallurgical research, and for leadership in welding engineering education."

PAUL W. POLK, vice-president of the Sheffield Corporation, Dayton, Ohio, has been granted a leave of absence to accept a commission as lieutenant (j.g.) in the United States Navy. OSCAR A. AHLERS, assistant to the president, has been named acting head of the distribution division.

Paul W. Polk, Vice-president of the Sheffield Corporation, Who Recently became Lieutenant (j.g.) in the U. S. Navy

JAMES TERRY has been appointed district manager of the Cincinnati, Ohio, sales office and warehouse of the Columbia Tool Steel Co., Chicago Heights, Ill. He succeeds the late W. G. SONDERMAN. Mr. Terry has been connected with the company for several years.

Pennsylvania

MYRON M. EICHER has been made works manager of the Jessop Steel Co., Washington, Pa., succeeding

Myron M. Eicher, New Works Manager of the Jessop Steel Co.

LAKE ERIE
ENGINEERING CORP.
BUFFALO, N.Y. U.S.A.

What LAKE ERIE HYDRAULIC PRESSES are doing now to help speed victory, measures the tremendous volume that can be expected in peacetime.

HARRY WILSON, JR., who was recently advanced to vice-president in charge of operations. Mr. Eicher became connected with the company in 1942.

W. H. HOLCOMB, formerly assistant to the president of the Baldwin Locomotive Works, Philadelphia, Pa., has been appointed to the newly created

W. H. Holcomb, Vice-president in Charge of Industrial Relations, Baldwin Locomotive Works

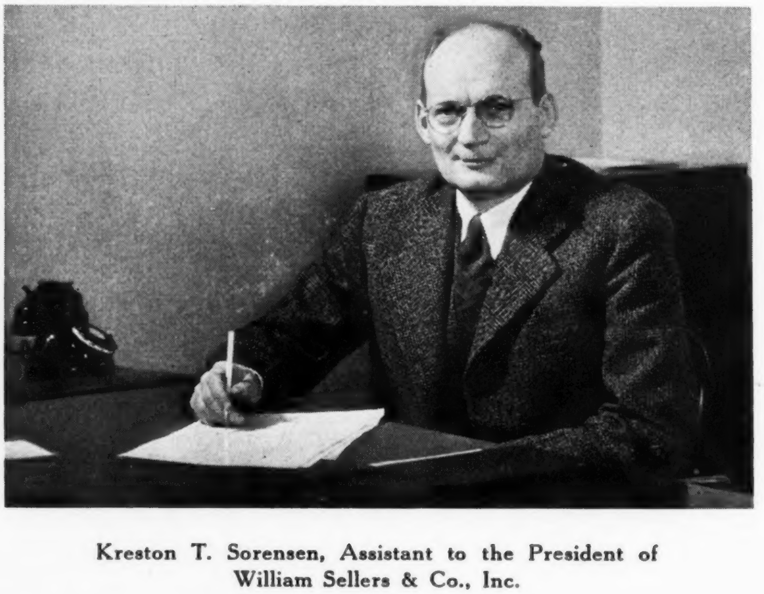
office of vice-president in charge of industrial relations. Mr. Holcomb entered the employ of the Pelton Water Wheel Co., San Francisco, Calif.—a Baldwin subsidiary—in 1919. He was made vice-president and general manager of the Pelton company in 1939. In 1942, he became associated with the Baldwin organization as assistant to the executive vice-president.

Photo Blank & Stoller

Russell M. Allen, Vice-president in Charge of Sales of Allegheny Ludlum Steel Corporation

RUSSELL M. ALLEN, formerly general manager of sales of the Allegheny Ludlum Steel Corporation, Pittsburgh, Pa., has been elected vice-president in charge of sales. Mr. Allen became connected with the Allegheny Steel Co. in 1920. In 1934, he was made assistant sales manager, a position that he continued to hold after the merger through which the Allegheny Ludlum Steel Corporation was formed in 1938. In 1940, he became general manager of sales.

KRESTON T. SORENSEN has become assistant to the president of William Sellers & Co., Inc., Philadelphia, Pa. Until 1941, Mr. Sorensen was associated with the Baldwin Locomotive Works; later he was in charge of design of ordnance equipment for the Ordnance Department.



Kreston T. Sorensen, Assistant to the President of William Sellers & Co., Inc.

JAMES J. NELSON, general manager of the Cramp Brass & Iron Foundries Division of the Baldwin Locomotive Works, Philadelphia, Pa., has been made vice-president of that division. Mr. Nelson has been with the Cramp

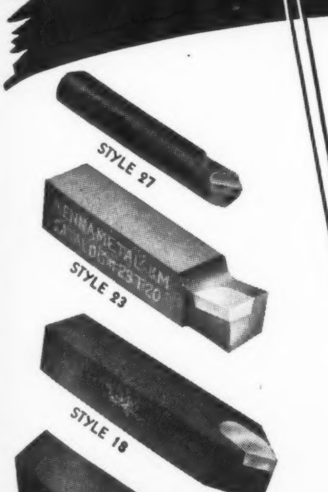
James J. Nelson, New Vice-president, Cramp Brass & Iron Foundries Division of Baldwin Locomotive Wks.

organization since 1932 as sales manager. Last year he was appointed general manager of the division.

REAR ADMIRAL H. G. BOWEN, U.S.N., has been awarded the Newcomen Medal by the Franklin Institute, Philadelphia, Pa., with the following citation: "In consideration of his long record of service with a group of engineers whose work is now such a vital part of the life of our nation, and particularly in view of his outstanding advocacy of the advance in steam engineering in this branch of our National Defense, as represented by the increase in steam pressures and temperatures used on equipment installed on its ships."

A. B. FARQUHAR CO., York, Pa., announces that on January 1 the limited partnership of A. B. Farquhar Co., Ltd., was dissolved, the firm becoming a corporation known as the A. B. Farquhar Co. W. J. FISHER, formerly vice-president and general manager, is president and general manager of the new firm; FRANCIS FARQUHAR, vice-president and assistant treasurer; E. H. FISHER, vice-president; and T. R. STANSFIELD, secretary-treasurer. The Farquhar firm was founded in 1856.

JOSEPH T. RYERSON & SON, INC., Chicago, Ill., has purchased the Pitts-



To get maximum steel-cutting production—consult KENNAMETAL field engineers about the proper application of KENNAMETAL, the wear-defying tool material whose chief ingredient is a unique, super-hard intermetallic compound (tungsten-titanium carbide). KENNAMETAL engineers will help you . . . (1) select the right grade . . . (2) choose the correct tool style . . . (3) determine the most efficient machine set-up . . . (4) install a money-saving tool maintenance program.

Yes, KENNAMETAL engineering service assures the *right* KENNAMETAL tool on every job . . . and performance studies show that the *right* KENNAMETAL tool, used properly, often can remove stock from the toughest steel up to 3½ times more efficiently than other carbides! There's a KENNAMETAL field engineer in your locality. Ask him for advice—and always keep a copy of our Tool Manual on hand. Write for one today.

KENNAMETAL

KENNAMETAL *Inc.*

147 LLOYD AVE., LATROBE, PA.

SUPERIOR CEMENTED CARBIDES

burgh steel warehouse plant of the Bethlehem Steel Co., located in Carnegie, Pa., adjacent to Pittsburgh. This property consists of a large modern warehouse building containing 150,000 square feet on an industrial site of several acres.

BENNETT S. CHAPPLE, JR., has been appointed assistant to the president of the Firth-Sterling Steel Co., McKeesport, Pa. Mr. Chapple was formerly assistant manager of sales in the New York district of the Carnegie-Illinois Steel Corporation.

Bennett S. Chapple, Jr., Assistant to President of Firth-Sterling Steel Co.

VINCENT K. ALEXANDER has been appointed sales manager of the Manheim Mfg. & Belting Co., Manheim, Pa., manufacturer of Veelos adjustable V-belts. For the last ten months, Mr. Alexander has served as acting sales manager; prior to that, he was in charge of the company's Chicago office.

EDWARD A. KRELLER has been appointed manager of the cast-to-shape department of the Jessop Steel Co., Washington, Pa. Mr. Kreller was associated for many years with the Detroit Alloy Steel Co. For the last nine years he has been works manager of that organization.

L. P. MCALLISTER, who has been metallurgical engineer for the Lukens Steel Co., Coatesville, Pa., since 1936, has been appointed assistant to the general superintendent, with the specific duty of handling quality control.

JENNINGS MACHINE CO., 3452 Ludlow St., Philadelphia 4, Pa., is the new name under which the business formerly known as PETERS ENGINEERING Co. will be conducted in the future.

Washington, D. C.

R. H. DAVIES has been appointed welding engineering representative in Washington, D. C., for the Lincoln Electric Co., Cleveland, Ohio. Mr. Davies will have headquarters at 410 Hill Bldg.

* * *

Film Showing Aircraft Factory Work in England

A pictorial record of how workers at an aircraft factory in the northwest of England assembled a Wellington bomber in twenty-four hours and forty-eight minutes is furnished in a film produced by the British Ministry of Information and released in the United States by Universal Pictures Co., Inc., Rockefeller Center, New York 20, N. Y. It is expected that this film will be shown in moving picture theaters throughout the United States. It is entitled "Wings in Record Time."

The picture begins by showing the riveters — mostly women — starting work on two sections of the fuselage. Then follow the electrical workers, the stitchers, the women who apply the weatherproofing, and finally, the assemblers.

* * *

Government-Owned Material and Equipment for Sale

Various types of raw materials and fabricated products, standard parts, motors, hardware, fabrics, precision tools, and other surplus stock and equipment are now being offered for sale by the Army Air Forces. Those interested in such materials and equipment, who wish to have their names on the active bidders' list, are invited to write to the Army Air Forces, Materiel Command, Midcentral Procurement District, 111 W. Jackson Blvd., Chicago 4, Ill., Attention, Redistribution and Salvage Section.

* * *

Counting by Weighing

A scale accurate to within one-thousandth of an ounce and intended for counting large numbers of small parts with speed and precision has been brought out by John Chatillon & Sons, 87 Cliff St., New York 7, N. Y. The parts to be counted are placed in a counting pan and brought to balance with a previously counted number of identical parts in the sample pan. The reading of a ratio scale enables the number of pieces to be determined more rapidly, and frequently with greater accuracy, than if counted in the ordinary way.

Obituaries

ROBERT W. THOMAS, director and treasurer of the Thomas Machine Mfg. Co., Pittsburgh, Pa., died on February 6 at his home in Glenshaw, Pa., after an illness of several months. Mr. Thomas was born in Scranton, Pa., and graduated from the University of Pittsburgh in 1926. He then entered the employ of the Thomas Machine Mfg. Co. founded by his father, George P. Thomas, Sr., in which enterprise he served in various capacities. He is survived by his wife—Mrs. Alva Jones Thomas—a daughter—Alva M.—two brothers, and five sisters.

JAMES A. NOLAN, New York State representative of the Carpenter Steel Co., Reading, Pa., died on January 17 at Rochester, N. Y., aged fifty-four years. Mr. Nolan had been associated with the Carpenter organization for thirty-three years.

FREDERICK J. MACWILLIAMS, one of the founders and the general manager of the Abart Gear & Machine Co., 4828 W. 16th St., Chicago, Ill., died on January 23, following a long illness, at the age of forty-nine years.

CHARLES E. HAHN, for many years connected with the Cincinnati Electrical Tool Co., Cincinnati, Ohio, and well known in the electrical tool field, died at his home in Cincinnati on February 7.

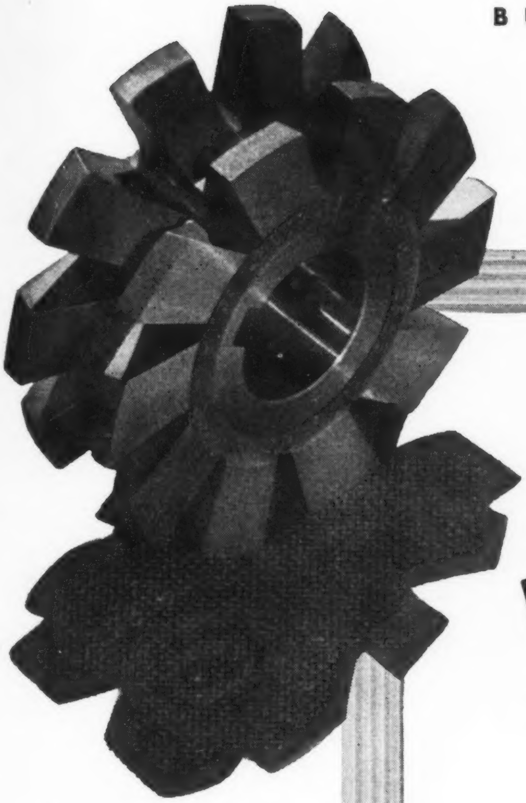
ALVA L. GRINNELL, who for many years was Detroit office district manager for the Rustless Iron & Steel Corporation, Baltimore, Md., died on February 3 after an illness of several years.

JOHN A. CAMM, president of the Camm Blades Machinery Co., Milwaukee, Wis., died on February 4. Mr. Camm had been identified with the machine tool industry in various capacities for a great many years.

* * *

Long Service Record of Standard Oil Employes

During the first six months of 1944, the long service records of over 1000 employes of the Standard Oil Co. of Indiana will be recognized by the company's long-service awards. A gold watch will be awarded to Frank Strelow, Milwaukee, Wis., for fifty years of service; gold pins set with diamonds will be presented to eight employes for forty years of service; gold pins will be awarded to 82 employes for thirty years' service; to 341 employes for twenty years' service; and to 633 employes for ten years' service.

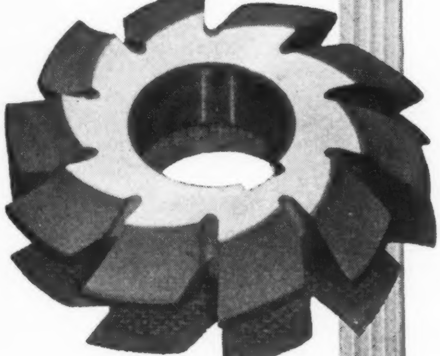


There are

FORM RELIEVED "TOMAHAWKS"

too ---

Genesee Tool Company is one of the few major tool companies completely equipped to produce *in quantities* both ground and unground form-relieved cutters of virtually all types—on short deliveries (6 to 8 weeks at the time this was written).



Thousands of these **"TOMAHAWK"** form-relieved cutters have been doing Yeoman's duty in turning out better war products.

We will be glad to quote you on your requirements.

GENESEE TOOL COMPANY
FENTON, MICHIGAN

* Registered Trade Mark

New Books and Publications

BLUEPRINT READING. By Fred Nicholson and Fred Jones. 141 pages, 7 1/2 by 10 inches. Published by the D. Van Nostrand Co., 250 Fourth Ave., New York City. Price, $2.

Fred Nicholson, one of the authors of this book, is instructor in mechanical drawing at the Henry Ford Trade School, and Fred Jones, co-author, is head of the drawing department of the Apprentice School of the Ford Motor Co.; hence both men have a thorough practical background for the preparation of a book of this character. The material and the methods of preparation are based on many years of experience in the field of vocational education. A brief review of arithmetic has been included in this text-book, as the authors have found that many students are handicapped because of their inability to solve comparatively simple mathematical problems. The main body of the book consists of fifty lessons and fifty blueprints. On many of the lesson sheets, pictorial drawings are shown, in addition to the working drawing. This helps the student to visualize the object shown on the drawing.

ENGINEERS' DICTIONARY—SPANISH-ENGLISH AND ENGLISH-SPANISH. By Louis A. Robb. 423 pages, 5 1/2 by 8 inches. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. Price, $6.

With the increasing volume of engineering business that is being conducted with the Spanish-speaking countries of Central and South America, a dictionary specifically covering engineering terms becomes of importance. The material published in this book has been accumulated by the author during a period of over twenty-five years. The compilation was originally prompted by the difficulties confronting the author, in the office of an engineering corporation, in handling technical translation. The field of the present volume is the vocabulary of civil engineering in all its branches, but obviously many mechanical and electrical terms are included. The author mentions, however, that no attempt has been made to deal completely with all mechanical or electrical engineering terms.

DIESEL LOCOMOTIVES—ELECTRICAL EQUIPMENT. By John Draney. 388 pages, 5 1/2 by 8 1/2 inches. Published by the American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Price, $3.75.

This is the second of two books on the operation and maintenance of railway Diesel locomotives. The first book dealt with the mechanical equipment, while the present book is devoted to the electrical equipment. It starts with an explanation of the electric current and proceeds to describe the principles of a generator, electrical power measurements, and transmission equipment. Then follow chapters describing in detail the electrical equipment of various types of Diesel electric locomotives, and giving specific instructions on operation and maintenance. These books are written in a simple, non-technical style, suitable for home study or for classroom use.

INTRODUCTION TO STEEL SHIPBUILDING. By Elijah Baker III. 242 pages, 5 1/2 by 8 1/2 inches; 181 illustrations. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Price, $3.

This text-book, written mainly for the apprentice shipbuilder, has been prepared in such a manner that it can be readily understood by anyone who has a desire to learn about shipbuilding. It is not intended for any particular shipyard trade, but endeavors to give the apprentices of all trades a basic understanding of the product they are helping to create. Mathematical treatment beyond what might be expected from the average high-school student has been avoided, and the text throughout is practical rather than theoretical. The book covers not only the regular shipbuilding subjects, but also such items as launching and stability.

SUGGESTED SHOP PROBLEMS FOR HAND SKILL PRACTICE IN AIRCRAFT AND SPECIALIZED SHEET-METAL WORK. By I. D. White. 104 pages, 8 1/2 by 11 inches. Published by the Metal Crafts Guild, P.O. Box 142, Flatbush Station, Brooklyn, N. Y. Price, $3.50.

This book contains six distinctive groups of simple procedures for developing manual skill, especially in sheet-metal work. It contains sixty projects suitable for home, shop, or school use, illustrated by seventy-eight blueprints. The subjects dealt with cover blueprint reading, sheet-metal drafting, layouts, patternmaking, precision hand-filing, assembly, and riveting.

SUCCESSFUL SOLDERING. By Louie S. Taylor. 76 pages, 5 by 7 1/2 inches; 24 illustrations. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Price, $1.

The process of soldering is perhaps used oftener and in more kinds of trades than any other simple method of joining metals; yet it is frequently performed incorrectly. This book has been prepared with a view to furnishing such information on the subject as will prove of most direct interest and value to the practical man.

WAGE INCENTIVES IN WARTIME. 47 pages, 6 by 9 inches. Distributed by Consolidated Management Consultants, 521 Fifth Ave., New York 17, N. Y.

This booklet has been written as a guide to increased production without extra man power. It covers wage incentive plans, job evaluation, and scientific work measurement.

FATIGUE TESTS OF COMMERCIAL BUTT WELDS IN STRUCTURAL STEEL PLATES. 140 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 344 of the Engineering Experiment Station. Price, $1.

Coming Events

MARCH 26-28—Annual meeting of the AMERICAN SOCIETY OF TOOL ENGINEERS to be held at Philadelphia, Pa. Adrian L. Potter, executive secretary, 2567 W. Grand Blvd., Detroit 8, Mich.

APRIL 25-28—THIRD WAR PRODUCTION FOUNDRY CONGRESS AND FOUNDRY SHOW of the American Foundrymen's Association, to be held at the Memorial Auditorium, Buffalo, N. Y., in conjunction with the forty-eighth annual meeting of the Association. Executive office, American Foundrymen's Association, 222 W. Adams St., Chicago, Ill.

MAY 22-24—Twenty-eighth annual meeting of the AMERICAN GEAR MANUFACTURERS ASSOCIATION at the Westchester Country Club, Rye, N. Y. Newbold C. Goin, executive secretary, Empire Bldg., Pittsburgh 22, Pa.

JUNE 26-30—Forty-seventh annual meeting of the AMERICAN SOCIETY FOR TESTING MATERIALS at the Waldorf-Astoria Hotel, New York City. For further information, address American Society for Testing Materials, 260 S. Broad St., Philadelphia 2, Pa.

OCTOBER 12-14—Semi-annual meeting of the AMERICAN SOCIETY OF TOOL ENGINEERS at Syracuse, N. Y. Adrian L. Potter, executive secretary, 2567 W. Grand Blvd., Detroit 8, Mich.

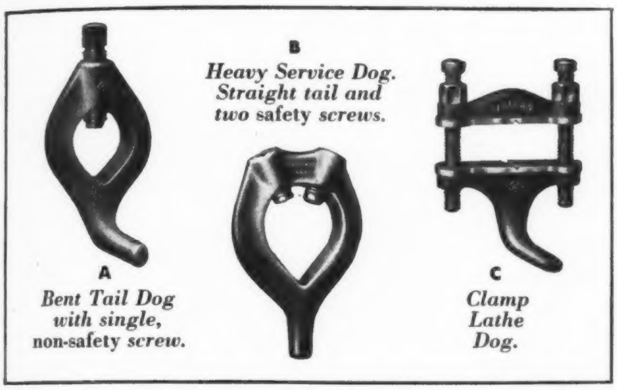
OCTOBER 16-20—Twenty-sixth annual meeting of the AMERICAN SOCIETY FOR METALS AND THE NATIONAL METAL CONGRESS, to be held at the Public Auditorium, Cleveland, Ohio. W. H. Eisenman, secretary, American Society for Metals, 7301 Euclid Ave., Cleveland.

THE **HOW** AND **WHY** OF

WILLIAMS DROP-FORGED TOOLS

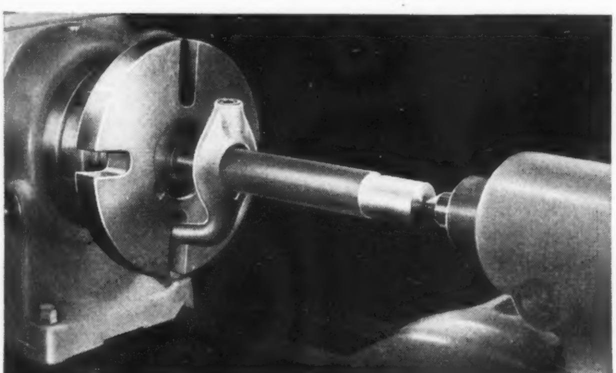
PROPER SELECTION AND USE OF LATHE DOGS . . . Data Sheet No. 23

Lathe Dogs provide the most common method of driving work mounted between centers. Two basic types are widely used: the Bent Tail Dog and the Clamp Dog. In Williams' line, the former type is supplied with *straight* or *bent* tail, and the Heavy Service sizes have two screws.



Safety and non-safety screws are now interchangeable in Williams' "Vulcan" Dogs A and B. This type is available with either bent or straight tail, and the Heavy Service sizes have two screws. Safety screws present less hazards to the operator.

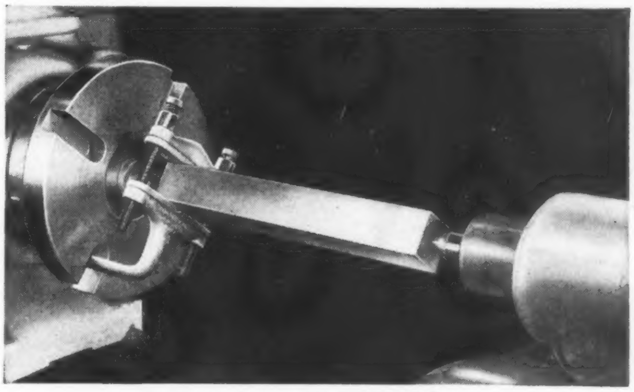
In selecting a Lathe Dog for a given job, begin by choosing a Dog whose capacity approximately fits the work. Too large a dog sets so far off center on the face plate as to cause vibration and inaccurate results. Dog sizes are expressed in inch capacity, i. e., a 5″ Bent Tail Dog will accommodate work up to 5″ diameter.



Application of Bent Tail Lathe Dog.

The next consideration is type of Dog. Bent Tail Dogs are used for practically all types of round work. If work is of small diameter or such that the bending or twisting action of the bent tail is objectionable, the straight tail pattern should be substituted. A projecting stud on the face plate is used to drive this Dog. The Clamp Dog is used to drive rectangular, hex and other than round work.

While the single screw pattern of the Bent Tail Dog is the most widely used, Dogs having two screws provide a more positive grip and should be used when the cutting operation imposes a severe driving load.

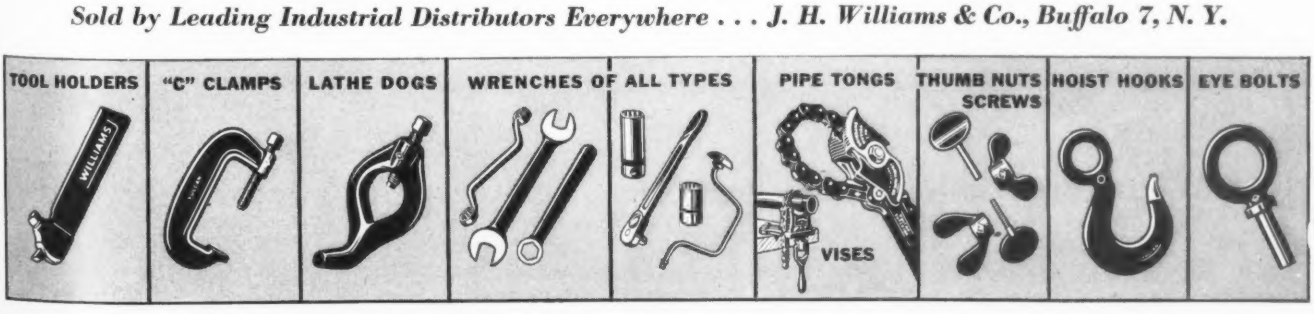


Application of Clamp Lathe Dog.

Both Bent Tail and Clamp Dogs should be located on the headstock end of the work so that the tail projects over the end far enough to securely engage a slot in the face plate. After the work has been placed between centers and the tailstock spindle tightened, make sure that the tail of the Dog moves freely in the face plate slot. Any cramping or binding here may lift the work off the live center and cause it to run eccentrically.

Centers should be sufficiently tight on the work that a firm grip is needed to rotate the work slightly back and forth by hand. If the Lathe Dog tail makes a clanking noise against the face plate slot when machine is started, centers need further tightening.

Sold by Leading Industrial Distributors Everywhere . . . J. H. Williams & Co., Buffalo 7, N. Y.



Classified Contents of This Number

Your Progress Depends Upon Your Knowledge of Your Industry